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**DOCUMENTATION OF  
THE TIROS III  
DATA REDUCTION PROGRAM**

**BY**

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## INTRODUCTION

The Tiros III Data Reduction Program was written by Robert Hite, Morris Frankel and George Martin at the Weather Bureau's Meteorological Satellite Laboratory. The documentation of the program was prepared at the National Aeronautics and Space Administration's Goddard Space Flight Center by Lena Fried.

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## INPUT to the Tiros III Data Reduction Program

Documentation Card

Logical Tape B4 - Radiation Digital Tape

Logical Tape A4 - Orbital Tape

## OUTPUT from the Tiros III Data Reduction Program

Logical Tape B3 - BCD Diagnostic Tape

Logical Tapes A6 and B6 - binary FMRT if sense switch 2 is up

Logical Tapes A7 and B7 - binary FMRT if sense switch 3 is up

## DEFINITIONS

**SWATH:** A set of earth viewing responses.

**JULIAN TIME:** Time elapsed since zero hour at Greenwich on launch day.  
Redefined every 100 days.

**THRESHOLD OR CRITICAL VALUE:** An arbitrary value of an IR response below which it is assumed that both sensors are viewing space. One sensor is viewing earth when the measured radiation exceeds threshold.

**DOWNWARD MODE:** The satellite is within a region such that either the wall or floor side of the radiometer faces earth exclusively for at least one complete spin revolution.

**ALTERNATING MODE:** The satellite is positioned such that either the wall or floor side of the radiometer, or both, views earth and sky in one revolution.

**NADIR ANGLE:** The angle measured at the intersection point at the satellite between some specified line and the local vertical.

**OPTICAL AXIS (N.A.):** The ray perpendicular to the image plane passing through the lens nodal points.

**SPIN AXIS POINT (SAP):** The point of intersection with the earth's surface of the satellite spin axis vector after that vector has been translated parallel to itself to an origin at the earth's center.

**SUBSATELLITE POINT (SSP):** Intersection of the local vertical passing through the satellite with the earth's surface.

## PROGRAM SUMMARY

## PART I

The primary function of Part I is to set up the input data which consist of the Radiation Digital tape (B4), an Orbital tape (A4) and a documentation card.

On the Radiation Input tape (IR) one file contains the data from one orbit. The file is divided into records consisting of  $4096 \pm 2$  words. The first record of a file on this tape is a BCD documentation record. This record must be present. The Analog to Digital converter puts six one's (111111) at the beginning of the tape in front of the first file of data for identification.

The documentation card contains all the quantities appearing in the IR documentation record plus some others. A cross check is made between the parameters on the card corresponding to those on the tape and a count kept of the number of disagreements. In any case, the card data is used.

As part of the input, the program is given the exact time of interrogation of the satellite and the data sampling frequency. Knowing this the start time of the file can be computed by counting the number of IR data points on the tape until the end of file code is reached. In doing this the program skips over TV, SS and EOR codes. The start time is about 90 minutes earlier than the interrogation time.

Once the time spanned by the orbit is known the orbit tape is searched for data corresponding to the same time interval. If the corresponding time cannot be found the program will halt after printing a message calling for either an earlier or later orbital tape. When the proper time interval is found, the program will read in 105 records (105 minutes) of the orbit tape and use this to construct tables of latitude of the subsatellite point, longitude of the subsatellite point, height of satellite, right ascension and declination of the spin axis point and nadir angle of the TV camera at minute intervals.

## PART 2

## A. Processing the IR Tape

As the satellite moves in its orbit the two radiometer sensors can be positioned relative to the earth in one of four ways:

1. One sensor views earth continuously for one or more revolutions while the other only views space (downward mode).
2. One sensor can view both earth and sky in one revolution while the other only views space (alternating mode 1).
3. Both sensors can view space.
4. Both sensors alternately view earth and sky in one revolution (alternating mode 2).

When going through the other half of the orbit the functions of the sensors are reversed. (See flow chart of Subroutine DIRECT).

The IR tape is scanned for a data word which exceeds threshold. It is assumed that both sensors are viewing space when a word is below threshold. (TV and SS tables are set up in the process but at present they are not used). Using this as the starting point of the swath the program counts ahead the number of consecutive data points greater than threshold. This is the first count. If it is greater than three times the number of IR responses / revolution (ZETA) it is used as the swath count. If it is less than  $3 \times \text{ZETA}$ , the swath count is set equal to the second count. This includes points less than critical value and stops when three consecutive such points are encountered.

A swath with fewer than 3 responses is discarded. If it has more than three the radiometer's direction and sensor being used are determined. However, a swath with more than three but fewer than eleven responses will also be discarded after this is done.

When a swath with more than 11 responses has been found and the sensor and direction determined the swath count is compared with theoretical size. If the difference is more than 25% and this is an alternating mode the data for this swath will be placed on the FMRT with negative signs.

In the event that the first swath is in an alternating mode but no previous responses have been below threshold, the program skips over data points until at least one such point is found. The next point exceeding threshold is now considered to be the beginning of the swath.

If the first swath is in the downward mode and no previous responses have been below threshold the swath is adjusted to contain an integral number of spin revolutions.

Once the starting point of the swath is decided, a test is made to see whether or not the point viewed is on earth. If it isn't the search for a good data point continues. If it is on earth the first data record of the swath is prepared and the data point is analyzed in terms of the energy measured by the five channels of the radiometer. The next four points are assumed to be on earth. They are also analyzed but only the alternating modes compare them with the critical value. If they are below threshold they are stored as negative values on the FMRT.

This process is repeated testing every fifth point's position on earth. Every minute, regardless of the position within the swath a new record is started. The swath ends under either one of these conditions:

- a. A point is found to be off the earth after a good point is found.
- b. The number of points output for this swath are greater than or equal to ZETA.
- c. The swath count, which is decreased by one for each output point, is equal to zero.

The end of swath procedure consists of finding the minimum nadir angle for the swath just completed along with the latitude and longitude of the point on earth being viewed when this nadir angle occurred.

The IR data is then searched for the beginning of the next swath.

## B. Producing the Binary Final Meteorological Radiation Tape

The FMRT is written as the IR tape is being analyzed. Its format is described below.

First, the documentation record of the FMRT gives the pertinent information for the orbit such as start time, end time, satellite spin, data sampling frequency, orbit number and a code indicating which ground station interrogated the satellite.

Each succeeding record on the FMRT covers approximately one minute of orbit time. The first five words of a record define the following for the start time of the record,  $t_0$ :

- a. Greenwich Hour Angle (GHA) of sun
- b. Declination of sun
- c.  $T_c$  and  $T_e$ , radiometer and electronics' temperature
- d. Satellite height
- e. Latitude and longitude of SSP

Words 6 to 24 form a block which is repeated within the record any number of times until the minute is up.

Word 6:  $t_1$ , the number of seconds past  $t_0$  when an earth viewing response is detected and every 5th response thereafter.

Word 6 to Word 9 give for  $t_1$ : latitude SSP, longitude SSP, latitude of viewed point, longitude of viewed point, nadir angle of optic axis, azimuth of optic axis.

Word 10 to Word 12: The energy measured by the 5 radiometer channels at  $t_1$ .

Word 13 to Word 24: Four successive data samples following the sample taken at  $t_1$ .

When the data has reached a point 60 seconds past  $t_0$  the end of record code is placed in the 3rd word of the last response and a new record is begun.

If an end of swath occurs before a minute is up the data continues to be output as before; after the end of swath code, the minimum nadir angle of the swath and its associated latitude and longitude are written.

When the end of file code word on the IR tape is sensed or the end of tape mark is encountered on the IR tape the program ends the current record on the FMRT and then places an end of file gap on the output tape. The program writes a diagnostic summary of the orbit and then either halts or goes on to the next file depending on a sense switch setting.

### C. The BCD Diagnostic Tape

A record is kept of pertinent quantities as an aid in analyzing the data processed for each orbit. The format and contents of the diagnostic tape can best be seen by referring to the subroutines HEADB3, ERROR, DTAIL2, DTAIL3, DTAIL4 and SUMMARY and the table of Diagnostic Counters.

# PART I

<u>From</u>	<u>To</u>	
BEGIN	AAA-1	<ol style="list-style-type: none"> <li>1. Rewind tapes and set low density.</li> <li>2. Initial record on IR Tape may or may not <sup>be</sup> read (SW1 up or down). Initial record is - 370000000000.</li> <li>3. Sense indicators (SI) set = 0.</li> <li>4. Read orbital tape documentation record giving start and end time of data on tape and float quantities.</li> <li>5. Go to AAA.</li> </ol>
AAA	ALA+12	<ol style="list-style-type: none"> <li>6. Read IR BCD documentation record.</li> <li>7. Convert BCD data to binary and float some of the quantities.</li> <li>8. Change millisecs to seconds in time quantities.</li> <li>9. Go to ALA +13.</li> </ol>
ALA+13	CHECK-1	<ol style="list-style-type: none"> <li>10. Read data card.</li> <li>11. Shift fixed pt. numbers from decrement to address; float others.</li> <li>12. Check to see which channel (2 or 4) can be used to correlate attitude.</li> <li>13. Go to CHECK.</li> </ol>
CHECK	A3 - 1	<ol style="list-style-type: none"> <li>14. Initialize documentation discrepancy count, XDCK.</li> <li>15. Compare IR documentation record quantities with data card quantities.</li> <li>16. Keep track of discrepancies.</li> <li>17. Print out orbit number and number of discrepancies on tape B 3 using ERROR subroutine.</li> <li>18. Go to A 3.</li> </ol>

A 3

All +1

19. Read a radiation tape data record.
20. If SI bit 1 = 1 go to A12 after trying to make sure there are no tape check lights on, even if it means attempting to read the record 3 times. The program accepts parity error.
21. If SI bit 1 = 0 (as it is the first time) set up basic time quantities with respect to end time or time of interrogation.
  - a. Define base day BDAY
  - b. Create a bank of seconds from base day RFET,  $\neq$  TIME,  $\neq$  CLOCKA
  - c. Define time increment between samples. TINC.
  - d. Define data sampling frequency, etc.
22. Set SI bit 1 = 1.
23. Go back to step 20.

A 12

B-1

24. Examine data words of IR record.
25. Skip TV and SS words.
26. For each useable data word TIME = TIME - TINC, where TIME is initially set to time of interrogation.
27. When an EOR mark is reached store  $T_c$  and  $T_e$  from previous record scanned in table TCTE, set SI bit 1 = 1 and go to A 3.
28. When an EOF is reached, the value of TIME at that point is taken to be start time RFST.
  - a. Using RFST set up basic time quantities with respect to start time.
  - b. Set up CLOCKB, CLOCKC, CLOCKD.
  - c. Backspace one file on IR Tape (B4).
29. Go to B

B                      C-1                      30. Using computed times CLOCKB and CLOCKD and orbital tape start time and end time, determine whether this orbital tape spans the proper time interval.  
31. If not halt with appropriate message.  
32. If it is, go to C.

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C                      C9-1                      33. Set SI bit 3=1.  
34. Read time from beginning of orbital record; float quantities.  
35. Compare with computed start times of IR tape.  
36. If they don't agree, skip a calculated number of words depending on the orbital tape times.  
    a. If SI bit 3=1, compute the words to skip and set SI bit 3=0.  
    b. If SI bit 3=0, skip 1439 records.  
37. Repeat the above steps until the orbital tape is positioned so that the time of the first record is equal CLOCKB.  
38. Go to C 9.

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C 9                      EDTD+10                      39. Read 105 records of orbital data without tape check or EOF.  
40. Data is in ODATA; float the 1st three words in each record which is the time identifying the data in the record.  
41. Using orbital data set up tables.  
    a. Latitude  
    b. Longitude  
    c. Height  
    d. Right Ascension  
    e. Declination  
    f. Nadir Angle  
    g. P SUP - not used

42. Smooth out any discontinuities in longitude table.
  43. Set up the time associated with the first record of orbital data in DBGOD 1,  
DBGOD2 and DBGOD3.
  44. Initialize Part 1 of program.
  45. Go to Part 2 (Call G).
-

## PART 2

### Section 1 - Set Up Attitude Data

From To  
G G1-1

1. If IOTA 1 read a card containing alternate values for right ascension and declination, otherwise go to G1.
2. Replace DECTAB and RATAB with these values.
3. Recompute NATAB using subroutine NADIR.
4. Go to G1.

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### Section 2 - FMRT Document Record

G1 G4P-1

5. Halt - programmed delay. Pressing start button will cause program to proceed.
6. Place the quantities which make up the 14 word document record of the FMRT in the output buffer WRITE.

a. DREF	word 1
b. CMO, CDY, CYR	word 2
c. RFSD, RFSH, RFSM, RFSS	word 3 to word 6
d. CDAY, CHR, CMIN, CSEC	word 7 to word 10
e. CSPIN	word 11
f. CDFR	word 12
g. COBN	word 13
h. CSTCOD	word 14

11

7. Copy documentation record on output tapes governed by SW2 and SW3 settings.
  8. Go to G4P
-

## Section 3 - Initialize at beginning of file

9. Clear WRITE buffer for data.
10. Write heading on B3, the BCD output tape, using HEADB3 subroutine.
  - ii. Determine basic time values:
    - a.  $TIME = CLOCKC$ , exact start time (secs.)
    - b.  $WATCH = CLOCKB$ , start time to earlier even minute (secs.)
    - c.  $DIAL = CLOCKC - CLOCKB$ , fx. pt. secs. past even minute.
    - d.  $TINCX$ ,  $TINC$  time increment between samples (fx. pt., fl. pt.)
12. Find ZETA, the number of IR responses per revolution using subroutine ZETA. Set Identifier code for EARTH equal to 2.
13. Initialize counters:
  - a.  $RCTR = 0$  record counter.
  - b.  $TVCTR = 0$  TV word counter.
  - c.  $SSCTR = 0$  Sun Sensor word counter.
  - d.  $DATCTR = 0$  the number of data words in the swath.
14. Set SI bit 5=1, SI bit 10=1.
15. Read a record from the IR tape skipping the documentation record.
16. By examining RHO either take  $T_c$  and  $T_e$  for that record from a table using subroutine TTTAB ( $RHO = 0$ ) or from the data card ( $RHO = 1$ )
17. If  $WATCH \geq 86,400$  secs. (1 day),  $WATCH 2 = WATCH - 86,400$ ,  $BDAY = BDAY + 1$ .  
If  $WATCH < 86,400$  secs.,  $WATCH 2 = WATCH$

18. Go to G7A.

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Section 4 - Set Up Heading For a New Data Record

G7A

G8-1

19. WATCH2 is converted from secs. to Julian day, hour, minute and seconds by CHTIM1.
20. WATCH2 is used as the interpolation time to find:
  - a. GHA of sun
  - b. Declination of Sun
  - c. Height of satellite
  - d. Latitude SSP
  - f. Longitude SSP

These, as well as the Julian time to the nearest minute,  $T_e$  and  $T_c$ , are placed in the WRITE buffer as the first five words of the FMRT record.

21. Determine GHA Aries using subroutine GHAA.

22. Go to G8.

---

Section 5 - Search for IR Data Words

G8

G12C

23. Examine IR buffer RDATA for useable data words.
24. Skip words that are all zeros.
25. If bit 35 of data word=0 test for TV, SS or EOR code and continue searching.

- a. TV code - /666666666666 - Store the word following the code which contains low resolution data and its associated time, TIME - CTVDL<sub>Y</sub>, in TVBUF. Stop storing when the table is full but continue keeping count in TVCTR.
  - b. SS code - /525252525252 - Store the time of this response, TIME - CSSDL<sub>Y</sub>, in SSBUF. When the table is full continue keeping count in SSCTR.
  - c. EOR code - /707070707070 - Read next record into RDATA; set up T<sub>c</sub> and T<sub>e</sub>. Keep count of record number in RCTR.
26. If bit 35=1, go to H.

H H4-1

#### Section 6 - Compare IR Useable Data Word With Critical Value

27. If word is /777777777777 go to EOF (end of file program).
28. Check CHANEL. If CHANEL is neither 2 or 4 there is an error. HALT.
  - a. CHANEL 2: unpack bits 7-13 of data word.
  - b. CHANEL 4: unpack bits 21-27 of data word.
29. Compare response with critical (threshold) value CRV4.
  - a. If response is above threshold go to H4.
  - b. If response is below threshold set SI bits 5, 6, 16 = 0.
30. If DIAL < 60, increase DIAL (DIAL = DIAL + TINCX) and TIME (TIME = TIME + TINC) and go to G8. If DIAL > 60 (one minute has passed) increase DIAL and TIME and go to EOR (end of record program). If the data remained below threshold for 1 minute (SI bit 10=1) a message to that effect is printed before going to EOR.

#### Section 7 - A Response Above Threshold has Been Detected

H H4A-1

31. Set SI bit 10 = 0.
32. If SI bit 16 = 1 go to J to see whether point viewed is on earth.  
If SI bit 16 = 0 and SI bit 6 = 1 go to H10A6 to increment XCTR12.

33. SI bit 16=0, SI bit 6=0. Calculate for beginning of swath
  - a. ADDR5 - address of current data word above threshold
  - b. TIME - current time broken down into DGNDAY, DGNHR, DGNMIN, DGNSEC
  - c. Height and N.A. of satellite at this time.
  - d. DGNCT1 - the number of responses in this swath (using subroutine AHEAD).
34. If  $DGNCT1 > 3 * ZETA$ ,  $DATCTR = DGNCT1$   
 If  $DGNCT1 \leq 3 * ZETA$ ,  $DATCTR = DGNCT2$ , where DGNCT2 is the number of responses in the swath past three below threshold (using subroutine AHEAD2).
35. If  $DATCTR > 3$  go to H10
36. Go to H4A with response count in TEST 2.

---

Section 8 - Discard Swaths with Fewer Than Four Responses

- |     |     |                                                                                                                                                                                                                                                                                                                                                                                         |
|-----|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H4A | H4H | <ol style="list-style-type: none"> <li>37. Skip a number of IR words = TEST2 while keeping track of TV, SS and EOR codes. Increment DIAL and TIME for each useable IR data word.</li> <li>38. Print statement that swath is being discarded using DTAIL2</li> <li>39. Set SI bits 6 and 20=0.</li> <li>40. If a minute's up (DIAL &gt; 60) go to EOR.</li> <li>41. Go to G8.</li> </ol> |
|-----|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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Section 9 - Swath Has More Than 3 Responses

- |     |      |                                                                                                                                                                                                                                                                                                                                     |
|-----|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H10 | H5-1 | <ol style="list-style-type: none"> <li>42. Set SI bits 7, 8, 9=0.</li> <li>43. Determine sensor and direction of view using subroutine DIRECT. SI bits 7, 8, 9 may be changed by DIRECT.</li> <li>44. If response count is greater than or equal to 11 go to H10A.</li> <li>45. Store swath count in TEST2 and go to H5.</li> </ol> |
|-----|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Section 10 - Discard Swaths with more than 3 Responses but Fewer than 11

H5

H9C

46. Skip a number of IR words - TEST2 while keeping track of TV, SS and EOR codes. Increment DIAL and TIME for each useable data word.
47. Print statement that swath is being discarded using DTAIL2.
48. Set SI bits 6 and 20 = 0.
49. If DIAL > 60 go to EOR.
50. Go to G8.

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Section 11 - Swath Count Greater Than 11

H10A

H10A5

51. Compute theoretical swath size SIGMA. If the wall side is viewing the earth (SI bit 8 = 1) the supplement of the N.A. is used when calling subroutine SIGMA.
52. If the actual number of responses differs from the theoretical number by more than 25% set SI bit 20 = 1.
53. Go to H10A6.

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Section 12 - Alternating Swath Seeks a Response Below Threshold Before Continuing

H10A6

H11-1

54. If this is the downward mode (SI bit 7 = 1) go to H11.
55. If at least one previous data word has been below threshold (SI bit 5 = 0) go to H22.
56. Increment DIAL and TIME.
57. Set SI bit 6 = 1.
58. Increment diagnostic counter XCTRL12 by one.

59. Go to G8.

Section 13 - Adjust Starting Point in Downward Mode

H11 H22-1

60. Set SI bit 20 = 0.
61. If at least one response encountered up to this point has been below threshold go to H22.
62. If the swath count has already been compared with ZETA (SI bit 12 = 1) go to H22.
63. The starting point of the downward mode is adjusted so that the remainder of the swath contains an integral number of spin revolutions. DIAL and TIME are incremented for each data word skipped.
64. Set SI bit 12 = 1.
65. Call DTAIL4 to print out the number of responses skipped (DGNCT5).
66. If DIAL > 60 go to EOR.
67. Go to H22.

Section 14

H22 H22

68. Set SI bit 6 = 1.
69. Go to J.

Section 15 - Find Parameters For This Point

J J3 + 6

70. For the current value of TIME get
  - a. height of satellite
  - b. lat. and long. of SSP
  - c. lat. and long. of SAP
  - d. N.A. of camera
  - e. GHA Aries
71. Downward mode (SI bit 7 = 1) go to J6.  
Alternate mode (SI bit 7 = 0) go to J3 + 7

Section 16 - Alternating Mode - is point on earth?

J3 + 7 J6-1

72. Call LALO: +1 N.A. ↓ in AC if floor side is viewing earth.

- 1 N.A. ↓ in AC if wall side is viewing earth.

- If the N.A. of the optic axis is + go to J10
- If the point cannot be located on earth (N.A. of optic axis is - ) diagnostic counter XCTR3 is increased by 1. DATCTR is decreased by 2 to account for its opposite on the other side of the horizon. DIAL, TIME and ADDR5 are adjusted. Set SI bit 16 = 1. Go to G8.
- If swath size exceeds maximum size for one spin revolution diagnostic counter XCTR5 is increased by 1. DIAL, TIME and ADDR5 are adjusted. Set SI bit 16 = 1. Go to G8.

Section 17 - Downward Mode - is point on earth?

J6 J10-1

73. Call LLA: +0 in AC if floor side is viewing earth.

- 0 in AC if wall side is viewing earth.

- If N.A. of optic axis is + go to J10
- If point is off earth increase diagnostic counter XCTR4 by 1. DATCTR is reduced by 2 to account for an adjacent point. DIAL, TIME and ADDR5 are adjusted. Set SI bit 16 = 1. Go to G8.

Section 18 - Point Viewed is on Earth

J10 J12A-1

74. Words 6 - 9 of the FMRT record are placed in the WRITE buffer. The current value of time is start time, STTIM.

Word	Decrement	Address
6	DIAL	lat. SSP
7	long. SSP	lat. viewed pt.
8	long. viewed pt.	N.A. of optic axis
9	azimuth of optic axis	0

75. Analyze the current data word using the subroutine CALIB. This results in the energy measured by each of the five medium resolution channels when viewing the point on earth. CALIB puts a 1 in bit 19 when the wall side is viewing.

76. Place these five values in the WRITE buffer:

Word	Decrement	Address
10	W (ch.1)	W (ch.2)
11	W (ch.3)	W (ch.4)
12	W (ch.5)	0

77. If SI bit 20 = 1 set the sign of these words ( - ) before placing them in the WRITE buffer. Keep a count of all negative data words in XCTRI0.

78. Increase DIAL and TIME. Increment the final swath count register DGNCT4. Reduce DATCTR by 1.

79. Go to J12A.

---

Section 19 - Set up Search for 4 More Points

J12A J12A + 2

80. Set TEST = 4

81. Go to J13

---

Section 20 - Search for 4 More Points

J13 M4A - 3

82. Look for the next useable data word while still keeping track of TV, SS, EOR and EOF codes.

83. In the downward mode analyze the data word with CALIB and store in the WRITE buffer without further checking.

84. In the alternating mode a data word is compared with the critical value before being analyzed by CALIB. If it is below threshold SI bit 11 is set = 1. If either SI bit 20 = 1 or SI bit 11 = 1 the data word is placed in the WRITE buffer with a negative sign and XCTRI0 is increased by 1.

85. Increase DIAL, TIME and DGNCT4. Reduce DATCTR by 1.

86. Set SI bit 11=0.
87. If DGNCT4 ≥ ZETA go to N, end of swath program.
88. TEST = TEST - 1.
89. Go to J13 until TEST = 0.
90. Go to M4A - 2.

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Section 21 - Repeat Blocks 6D to 24A of FMRT Record for New Data

M4A-2 M14-1

91. If DATCTR=0, go to N.
92. Start another block of data defining the next group of five points in the swath.
  - a. Search for useable data word
  - b. In alternating mode set SI bit 11=1 when data word falls below threshold. Test DATCTR for end of swath.
  - c. Given TIME set up height, lat. SSP, long. SSP, lat. SAP, long. SAP, GHA of Aries and N.A. of camera.
93. Determine whether this point is on or off earth.
  - a. Go to M14 if it is on earth.
  - b. If point is off earth increment the proper diagnostic counter. XCTR6, XCTR7 and XCTR8 are analogous to XCTR3, XCTR4 and XCTR5 except that they are used after at least one point has been located on earth. Increase times and go to N.
  - c. If the point is off earth in the downward mode and DGNCT4 < ZETA print diagnostic DTAIL4 before going to N.

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Section 22 - Nth Point is on Earth

M14 N-1

94. Place DIAL, lat. SSP, long. SSP etc. in WRITE buffer.
95. Analyze data word with CALIB and place in WRITE buffer taking SI bits 11 and 20 into account as described in section J13.
96. Increase DIAL, TIME and DGNT4. Decrease DATCTR by 1.
97. Set SI bit 11=0.

98. If DGNCT4 < ZETA go to J12A for more data.

If DGNCT4 ≥ ZETA terminate swath. Go to N.

---

Section 23 - Begin End of Swath Program

NM-1

99. If this is downward mode go to NM.

100. In the alternating mode the program skips a number of useable data words on this side of the swath to make XCTR9 = XCTR3.

---

Section 24 - Compute End of Swath Quantities and Set Up for Next Swath

NM EOR-1

101. The current value of TIME is ENDTIM.

102. The average time for the swath  $MINTIM - STTIM + (ENDTIM - STTIM) / 2$  is used to find height, lat. SSP, long. SSP, lat. SAP, long. SAP, GHA Aries and N.A. of camera.

103. These quantities are input to MINNA, the subroutine which gives the minimum N.A. of the IR Optic Axis for this swath and the latitude and longitude of the point viewed when this N.A. occurred.

104. Place the end of swath code / 777777777777 in the WRITE buffer followed by the minimum N.A. and its associated lat. and long.

105. Call DTAIL to print the diagnostic data for this swath.

106. Re-set SI bits 6, 11, 13, 18, 20 = 0.

107. Keep a cumulative count of XCTR3 in XCTR3A.

108. Re-set XCTR3, XCTR9, XCTR10, DATCTR = 0.

109. If DIAL > 60 go to EOR.

110. Go to G8.

---

# Section 25 - End of Record Program

EOR EOT-1

110. Place EOR code /5252525252 in the 3rd word of the last response of this swath.
112. Copy the data words in the WRITE buffer on to the output tapes. In case of tape trouble print diagnostics.
113. If end of tape mark is sensed, halt.
114. Set SI bit 6 = 0.
115. Clear WRITE buffer.
116. Re-set DIAL and WATCH2: DIAL = DIAL - 60, WATCH2=WATCH 2 + 60.
117. Go to G7A, new data record.

# Section 26 - End of OutputTape Program

EOT EOTE

118. When the subroutines AHEAD or AHEAD2 senses the end of tape mark transfer is made to EOT upon exit from the subroutine.

A count is kept in XCTRL11 of the number of useable data words skipped over in the process of searching for an EOF mark. When it is encountered go to EOF.

# Section 27 - End of File Program

EOF EOF+6

119. Place the EOR code in the 3rd word of the last response of this swath.
120. Copy the WRITE buffer onto the output tape. Print diagnostics in case of tape trouble.
121. Write EOF on all FMR tapes.
122. Initialize address references to TVBUF, SSBUF and RDATA.
123. Call FINIS to end off program.

A H E A D SUBROUTINECALLING SEQUENCE:

CALL AHEAD  
PZE ADDR5, address of 1st. response  
PZE CHANEL, designated channel  
PZE ZETA, No. of I.R. responses / rev.  
EOT Return  
Return with count in A C, fx. pt.

PURPOSE: AHEAD determines swath size by counting the number of consecutive digital responses in the I R radiation data starting at ADDR5 which exceed the critical value.

METHOD:

1. Search data words discarding T V, SS, EOR and zero words.
2. Test each data word to see whether it's above or below threshold. The count ceases when a word is encountered which falls below threshold.
3. The tape B 4 is repositioned in case it was moved then program exits with count in A C.
4. In case an EOT is reached while writing the FMRT the count up to that point is compared with ZETA. If it is less than ZETA exit occurs without examining the tape position.

A H E A D 2 SUBROUTINE

CALLING SEQUENCE:      CALL AHEAD2  
                         PZE ADDR 5, Address of 1st. response  
                         PZE CHANEL, Designated channel  
                         PZE ZETA, No of IR responses / revolution  
                         EOT return  
                         Return with count in AC (fx. pt.)

PURPOSE: To determine swath size AHEAD 2 counts from a given location of the IR radiation data until it reaches three consecutive digital responses which fall below threshold value.

METHOD:

1. Search data words, discarding TV, SS, EOR and zero words.
2. Test each data word to see whether it's above or below threshold, keeping a separate count of each. If one or two consecutive data words below threshold occur between data words which exceed threshold, they are added on to that count. As soon as three consecutive data words fall below threshold the count ends.
3. When counting ends AHEAD2 repositions the tape B 4 to where it was when the routine called, and exits with the count in the AC.
4. In case an EOT is reached when writing the FMRT, the count is compared with ZETA. If it is less than ZETA exit occurs without examining tape position.

### C A L I B SUBROUTINE

<u>CALLING SEQUENCE:</u>	CALL C A L I B PZE T A U PZE T A U+1 PZE T A U+2 Return	storage for results
--------------------------	---------------------------------------------------------------------	---------------------------

The D A T A word is in the A C when C A L I B is called.

PURPOSE: C A L I B analyzes the data word in the A C, which is greater than the critical value, converting it to the energy measured by each of the 5 radiometers at a time T.

METHOD:

1. The data word is separated into five groups of 7 bits each, D 1, D 2, ... D 5, which are then floated.
2. Using  $T_c$  floated and D1, the calibration table T B L 1 is interpolated for W 1. The resulting value is fixed. The same is done using D 2, T B L 2, D3, T B L 3, etc. to find W2, W3 ... W5. In case we're interested in the wall side tables T B L 6, T B L 7 ... T B L 10 are used instead. If  $W_n$  is negative it is replaced by zero.
3. W1 and W2 go in Tau<sub>decr.</sub> and addr.  
 W3 and W4 go in Tau+1<sub>decr.</sub> and addr.  
 W5 and O goes in Tau+2<sub>decr.</sub> and addr.
4. Before exiting to main program C A L I B will place a 1 in bit 19 of TAU, TAU+1 and TAU+2 if this is the wall side.

# CARD SUBROUTINE

CALLING SEQUENCE:      CALL CARD  
Return

PURPOSE: CARD reads in the document card according to a specified format and stores the quantities in the proper locations.

## METHOD:

<u>COLUMN</u>		<u>LOCATION IN STORAGE</u>
1 - 4	Orbit Number	COBN
5 - 8	Julian day of interrogation	CDAY
9 - 10	Julian hour of interrogation	CHR
11 - 12	Julian minute of interrogation	CMIN
13 - 18	Julian second of interrogation	CSEC
19 - 20	Calendar year	CYR
21 - 22	Calendar month	CMO
23 - 24	Calendar day	CDY
25 - 30	Sun sensor delay	CSSDLY
31 - 36	T. V. delay	CTVDLY
37 - 42	Spin rate	CSPIN
43 - 45	Sampling frequency of data	CDFR
46	Station code	CSTCOD
47 - 49	Threshold Value for CH 4	CRVAL
50	Attitude source indicator	IOTA
51	Temperature correction indicator	KAPPA
52	Temperature source indicator	RHO
53 - 57	Temperature of electron	CTE
58 - 62	Temperature of radiometer	CTC
63	Channel designation	CHANEL

CHTIM1 SUBROUTINE

CALLING SEQUENCE:      Time in AC in secs.  
                            CALL CHTIM1  
                            PZE L1  
                            PZE L2  
                            PZE L3  
                            PZE L4

PURPOSE: Given a time in secs. in the AC, CHTIM1 will convert it to days, hours, minutes, seconds and stores the results in L1, L2, L3, and L4.

METHOD:

1. BDAY is used as the base day and stored in L1. One is added to this for each integral day (86,400) found in the given time.
2. When the time is reduced below 86,400 secs. a similar process determines the number of hours, minutes and seconds.

## D E T A I L   S U B R O U T I N E

CALLING SEQUENCE:

CALL	DETAIL
PZE	DGNDAY
PZE	DGNHR
PZE	DGNMIN
PZE	DGSEC
PZE	DGNCT1
PZE	DGNCT2
PZE	DGNCT3
PZE	DGNCT4
PZE	DGNNA
PZE	XCTR1
PZE	XCTR2
	etc.
	etc.
PZE	XCTR10
	Return

PURPOSE: At the end of each swath DETAIL is called to write a line of diagnostic data on B 3, the BCD output tape.

METHOD: The quantities listed in the calling sequence are placed under columns 1 - 19 in that order. The names of columns 1 - 19 are listed in the description of the HEADB 3 subroutine. If sense switch 4 is down the diagnostics are printed on line as well as written on B 3.

D I N I SUBROUTINE

CALLING SEQUENCE:       $T_c$  (ft. pt.) in MQ  
                             D (fl. pt.) in AC  
                             CALL DINI  
                             HTR TABLE, 1, X  
                             HTR 1, 0, Y  
                             Return with result in A C

PURPOSE: DINI is called by CALIB to perform double interpolation in the table specified in the calling sequence. X gives the number of entries of  $T_c$  and Y gives the number of pairs of entries of D,  $f(D)$  for each value of  $T_c$ .

METHOD: DINI is another entry point for TIN1. It uses TIN1, single interpolation, a number of times until the unknown is found. Interpolation is first done along D and then along  $T_c$ .

DIRECT SUBROUTINE

CALLING SEQUENCE: Time in A C  
 CALL DIRECT  
 PZE ADDR 5, first I R response in swath  
 PZE OMEGA+6, swath count  
 PZE CHANEL, channel  
 Return, with N.A. of I R optic axis in BUFR+10  
 and S.I. bits 7, 8, 9 set according to the orientation.

PURPOSE: At the beginning of a swath the direction of view and the sensor being used are determined by DIRECT.

METHOD: ( See flow chart of DIRECT )

1. Given the time  $t$ , the tables are interpolated for height, lat. SSP, long. SSP, N. A. of the camera, etc.
2. As the N. A. increases from  $0^{\circ}$  to  $180^{\circ}$  there are angles, depending on the height, which divide the orbit into zones within which certain facts about the satellites orientation are known. A mirror image of this occurs as the N.A. goes from  $180^{\circ}$  to  $360^{\circ}$ .  
 $0^{\circ}$  to ANGLE 1, Zone 1 - The floor side views the earth exclusively; the wall side views space exclusively.  
 ANGLE 1 to ANGLE 2, Zone 2 - the floor side views earth and sky alternatively; wall side views space exclusively.  
 ANGLE 2 to ANGLE 3, Zone 3 - Floor and Wall sides alternately view earth and sky.  
 ANGLE 3 to ANGLE 4, Zone 4 - The Wall side views earth and sky alternatively; floor side views space exclusively.  
 ANGLE 4 to  $180^{\circ}$ , Zone 5 - The Wall side views earth exclusively; floor side views space exclusively.

3. If the N.A. and swath count indicate that the satellite is outside of Zone 3 S1 bits 7, 8, 9 are set as follows and exit occurs.

Zone 1        1, 0, 0

Zone 2        0, 0, 0

Zone 4        0, 1, 1

Zone 5        1, 1, 1

4. If the satellite is in Zone 3 the program counts ahead 25 swaths in an attempt to determine whether the odd swaths are increasing or decreasing in size. By taking account of the direction the satellite moves around the earth the radiometer side viewing the earth can be found. A record is kept of the previous swath so that two counters may be set, ALTER and LAST, indicating whether or not alternation is being forced and which side is viewing earth.

DTAIL 2 SUBROUTINE

CALLING SEQUENCE:      CALL DTAIL2  
                         PZE DGNDAY  
                         PZE DGNHR  
                         PZE DGNMIN  
                         PZE DGNSEC  
                         PZE DGNCT1  
                         PZE DGNCT2  
                         PZE DGNCT3  
                         PZE DGNCT4  
                         PZE DGNNA

PURPOSE: A swath is discarded if it has fewer than 11 responses. Whenever this is done DTAIL 2 is called to write a line of diagnostic data on B 3.

METHOD: The quantities in the calling sequence are printed out along with the statement "Entire Swath Discarded".

DETAIL 3 SUBROUTINE

CALLING SEQUENCE:      CALL DETAIL 3  
                         PZE DGNCT5  
                         Return

PURPOSE: When starting in the downward mode the program moves the data starting point so that there are an integral number of spin revolutions remaining in the swath. DETAIL 3 indicates how many points (the contents of DGNCT5) were skipped.

METHOD: DETAIL 3 writes the following sentence on the B3 diagnostic tape.

" \_\_\_\_\_ Responses discarded to adjust starting location of downward mode "

D T A I L 4   SUBROUTINE

CALLING SEQUENCE:      CALL D T A I L 4  
                              Return

PURPOSE: If in the downward mode (SI bit 7 = 1) a point is found to be off the earth before the final count (D G N C T 4) of points in the swath reaches ZETA, the number of IR responses in a revolution, an error has occurred and the swath is terminated.      D T A I L 4 indicates this has happened on the diagnostic tape.

METHOD: A message is printed on B 3.    " Downward mode swath has terminated because a major point was found to be off the earth."

## EARTH SUBROUTINE

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### CALLING SEQUENCE:

	CALL EARTH
	PZE satellite height
	PZE latitude SSP
	PZE longitude SSP
INPUT	PZE latitude SAP
TO	PZE longitude SAP
EARTH	PZE identifier
	PZE delta alpha
	PZE delta beta
	PZE latitude of IR optic axis
OUTPUT	PZE longitude of IR optic axis
FROM	PZE N.A. of IR optic axis
EARTH	PZE azimuth of IR optic axis
	Return

### PURPOSE:

Subroutine to locate any point within the field of view.

### METHOD:

A complete and detailed writeup of EARTH is being prepared by Morris Frankel of the Weather Bureau's Meteorological Satellite Laboratory. Following is a brief explanation of the inputs and the geometry involved.

The sixth item in the calling sequence, identifier, is set early in the main program and can have any one of three values:

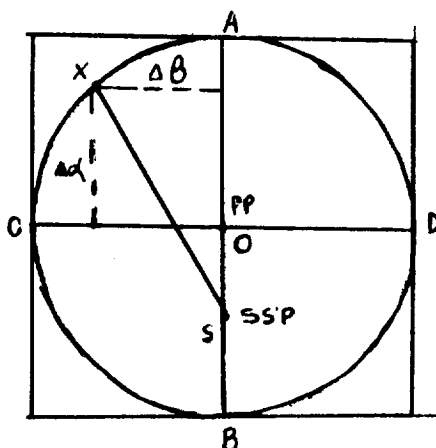
0 - the fourth and fifth items in the calling sequence refer to the principal point.

1 - the principal point is not on earth.

2 - the fourth and fifth items in the calling sequence refer to the spin axis point

Identifier is set equal to 2 in this program.

If we draw a plane perpendicular to the spin axis and project on it the principal point (the point of intersection of the camera optical axis and the image plane) the SSP and the path of the radiometer in one revolution we get:



$\widehat{ACBD}$  is a circle centered at PP. The angular distance  $\widehat{AO}$  is  $45^\circ$ , the angular distance of the radiometer from the camera. Points viewed by the radiometer lie on the circumference of the circle. If  $x$  is such a point,  $\Delta\alpha$  and  $\Delta\beta$  are its distances from the axis CD and AB. Using these quantities EARTH computes  $\widehat{XS}$ , the N.A. of the IR optic axis.  $\widehat{OS}$  is the N.A. of the camera.

If the point is off the earth the N.A. is set to - 0.

E R R O R   S U B R O U T I N E

CALLING SEQUENCE:      CALL ERROR, FOBN, X DOCK  
                                 Return

PURPOSE: To indicate on the diagnostic tape B3 the number of discrepancies, if any, between the values on the data card and those on the IR documentation record.

METHOD: The following sentence is written on B3:

"Orbit No. \_\_\_\_\_ . \_\_\_\_\_ documentation constants do not agree with card data."

FINIS SUBROUTINECALLING SEQUENCE:CALL FINIS

PURPOSE: FINIS sets up quantities to be output in the form of a diagnostic summary at the end of an orbit, after which it either goes back to the beginning of the main program or writes end-of files on the FMRT tapes, rewinds and unloads them and halts.

METHOD:

1. The quantities CLOCK A, CLOCK B, CLOCK C, CLOCK D are broken down into day, hour, minute and second.
2. Using the subroutine SUMARY the pertinent values for the orbit are written on A 3 and then the program halts.
3. When the start button is pressed, sense switch 6 is tested. If it is up clear core, skip over E O F gap on B 4 and transfer back to the beginning of the program.
4. If sense switch 6 is down write the second E O F on the appropriate output tapes, rewind and unload them and then halt. This is the final program stop.

G H A A SUBROUTINE

CALLING SEQUENCE:      CALL GHAA  
Return with result in A C

PURPOSE: GHAA computes the Greenwich hour angle of Aries in floating point for a particular time of the year.

METHOD:

1. The subroutine picks up the time from M O F X (month, fl. pt.), D Y F L (calendar day, fl. pt.), and time (secs. fl. pt.).
2. The base value of GHA Aries according to month is picked from the table M O N I O. Knowing the degree change per day and per second and D Y F L and TIME, the increment to be added to the monthly value is computed.

## H E A D B 3 SUBROUTINE

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CALLING SEQUENCE:      CALL H E A D B 3  
                            Return

PURPOSE: H E A D B 3 writes the 2 line heading on B 3, the B C D output diagnostic tape.

METHOD:

The B C D output is written in the form of 19 columns. H E A D B 3 produces the following headings.

Col. 1	Day	
Col. 2	Hour	Start
Col. 3	Minute	
Col. 4	Seconds	Time
Col. 5	First Count	
Col. 6	Second Count	
Col. 7	Theoretical Count	
Col. 8	Final Count	
Col. 9	Nadir Angle	
Col. 10	One	
Col. 11	Two	
Col. 12	Three	
Col. 13	Four	
Col. 14	Five	Diagnostic
Col. 15	Six	Counters
Col. 16	Seven	
Col. 17	Eight	
Col. 18	Nine	
Col. 19	Ten	

LALO SUBROUTINE

CALLING SEQUENCE:     $\pm$  | N.A. of camera | in A.C.  
                               CALL LALO  
                               ERROR RETURN - swath size too big  
                               RETURN

PURPOSE:    To determine the N.A. of the IR optic axis of a point in the alternating mode using the subroutine EARTH.

METHOD: (See subroutine EARTH)

The first time LALO is entered per orbit (SI bit 15=0) it sets up the angular distance between each viewed point, X, as a function of spin and data frequency. For each swath the central angle, psi, is found given X and the number of data points in the swath. The central angle is equivalent to the number of degrees in a circular field covered by the points in a swath. Using the current central angle LALO computes  $\alpha$  and  $\beta$  and calls EARTH after converting the quantities in the calling sequence to acceptable units.

If the first point in a swath is off the earth, the main program sets SI bit 16=1. The next time through LALO the program will decrease the central angle by the distance traversed by one point, X, reset SI bit 16 to 0 and call EARTH. This process is continued until a point is found to be on earth, e.g., LALO is entered with SI bit 16=0. After this the remaining central angle is decreased by 5X each time since LALO is entered for every 5th point until the end of swath. Since this is the alternating mode an error return occurs when the number of points in the swath exceeds ZETA.

The subroutine treats the wall and floor sides separately. A (+) in the AC upon entering LALO indicates floor while (-) means wall. For example, SAP is inverted before calling EARTH if the wall side is being used.

## LLA AND LLA1 SUBROUTINE

CALLING SEQUENCE:  $\pm 0$  in AC

CALL LLA or LLA1

RETURN with N.A. of IR optic axis in BUFR  $\mp 10$

PURPOSE: To find the N.A. of IR optic axis for a point in the downward mode by using the subroutine EARTH. LLA is called for the first point in a swath. LLA1 is called for the Nth point in a swath.

METHOD: (see subroutines EARTH and LAL0)

The first time LLA is entered per orbit (SI bit 17 = 0) it sets up the angular distance between each viewed point, X, as a function of spin and data sampling frequency.

The central angle of the first swath is set equal to  $360^{\circ}$  which is equivalent to the number of degrees in a circular field (one revolution) covered by the points in the swath. Depending on SI bit 16 (1 or 0) which is set by the main program the next point in the swath will be found by a 1 X or 5 X correction to the current central angle. This continues until a point is found on earth (SI bit 16 = 0) and 5 X corrections continue until end of swath.

After a certain point is reached within the swath a correction angle for the starting point of the next swath is computed. This is to compensate for the case when there's a gap between the first and last point of the current swath.

The sign of the AC upon entering LLA or LLA1 indicates whether floor (+) or wall (-) is being used. For the wall case the initial central angle is set to zero instead of  $360^{\circ}$  and the SAP is reversed.

MINNA SUBROUTINE

CALLING SEQUENCE:      CALL MINNA  
                              Return

PURPOSE: To compute the minimum N.A. of the IR optic axis in a particular swath. This is done at the end of a swath.

METHOD: The minimum time of a swath, MINTIM is just the average time:  
$$\text{MINTIM} = \text{STTIM} + (\text{ENTIM} - \text{STTIM}) / 2.$$

Before calling MINNA the height, lat. SSP, long. SSP, lat. SAP, long. SAP and N.A. camera are found for time = MINTIM. MINNA picks up these values from the BUFER block, converts them to a form acceptable to the subroutine EARTH and then calls it. EARTH finds the N.A. of the optic axis based on these values and stores it as well as the lat., long. and azimuth of the point on earth being viewed at this time in BUFER+23, BUFER+25, BUFER+26, BUFER+24. MINNA converts back to degrees and makes the longitude positive if necessary before returning to the main program.

## Return

**METHOD:**

- the nadir angle, SIDE A, is found. The subroutine used, SFTSI, is part of a package for solution of oblique spherical triangles used with EARTH.

## S I G M A   S U B R O U T I N E

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### CALLING SEQUENCE:

CALL SIGMA

PZE CSPIN,    spin rate

PZE FCDFR,   data sampling frequency

PZE SIGNAD,   nadir angle

PZE BUFER,    height

PZE OMEGA +8, storage for answer

Return

PURPOSE: Given the quantities in the calling sequence compute the theoretical swath count.

METHOD:    Sigma is defined as:

$$\sigma = ( \tau \times 550 ) / ( \text{SPIN} \times \text{DATFR} )$$

where  $\tau$  is the angular measure of the earth viewed in one spin revolution.

$\tau = 360^\circ - \psi$ ,  $\psi$  being the space viewed in one spin revolution.  $\psi$  is found using the relationship:

$$\cos \left( \frac{\psi}{2} \right) = (\alpha - \theta) / \beta$$

where

$$\alpha = \cos ( \text{N.A.} ) \cos ( \gamma )$$

$$\beta = \sin ( \text{N.A.} ) \sin ( \gamma )$$

$$\gamma = 47.5^\circ, \text{ the angle between the spin axis and}$$

midpoint of radiometer cone.

$$\rho = \text{earth's radius ( R )} + \text{satellite height}$$

$$\theta = \sqrt{1 - \left( \frac{R}{\rho} \right)^2}$$

SOLAR SUBROUTINECALLING SEQUENCE:

CALL SOLAR

PZE Location of Calendar month, o, location of calendar day.

PZE GHA table address, o, DEC table address

PZE loc. of time in secs. expressed as degrees

Return with SOLAR GHA & DEC in MQ & AC respectively.

PURPOSE: Solar computes the Greenwich hour angle and declination of the sun for any data within a particular year.

METHOD: (See description of Solar Ephemeris tables, GHA and DEC)

1. Given a month (m) the addresses  $GHA + (m-1) \times 12$  and  $DEC + (m-1) \times 12$  are computed
2. Using the above as the initial locations from which interpolation for d is to proceed, GHA and DEC are found.

S U M A R Y SUBROUTINE

<u>CALLING SEQUENCE:</u>	CALL SUMARY
	PZE FLOBN
	PZE DBGOD1
	PZE DBGOD 2
	PZE DBGOD 3
	PZE CLOCK A
	PZE ADAY
	PZE AHR
	PZE AMIN
	PZE ASEC
	PZE CLOCK B
	PZE BDAY
	PZE BHR
	PZE BMIN
	PZE BSEC
	PZE CLOCK C
	PZE CDAY
	PZE CHR
	PZE CMIN
	PZE CSEC
	PZE CLOCK D
	PZE DDAY
	PZE DHR
	PZE DMIN
	PZE DSEC
	PZE TIME
	PZE BASDAY
	PZE FTVCTR
	PZE FSSCTR
	PZE XCTR 1

PZE XCTR 2  
PZE XCTR 3 A  
PZE XCRT 4  
PZE XCTR 5  
PZE XCTR 6  
PZE XCTR 7  
PZE XCTR 8  
PZE XCTR 9  
PZE XCTR 10  
PZE XCTR 11  
PZE XCTR 12  
PZE RATAB+1  
PZE RATAB+209  
PZE DECTAB+1  
PZE DECTAB+209  
PZE FLZETA

Return

PURPOSE: SUMMARY is called by the subroutine FINIS at the end of the program to write out the quantities in the calling sequence, the diagnostic summary at the end of the BCD diagnostic tape B3.

METHOD: A sixteen line diagnostic summary is printed as follows:

Diagnostic summary for orbit \_\_\_\_\_.

Orbital Data started at \_\_\_\_ day \_\_\_\_ hr. \_\_\_\_ min. \_\_\_\_ secs.

CLOCK A \_\_\_\_\_ day \_\_\_\_ hr. \_\_\_\_ min. \_\_\_\_ secs.

CLOCK B \_\_\_\_\_ day \_\_\_\_ hr. \_\_\_\_ min. \_\_\_\_ secs.

CLOCK C \_\_\_\_\_ day \_\_\_\_ hr. \_\_\_\_ min. \_\_\_\_ secs.

CLOCK D \_\_\_\_\_ day \_\_\_\_ hr. \_\_\_\_ min. \_\_\_\_ secs.

SUMARY SUBROUTINE CON'T.

Time \_\_\_\_\_

Base Day \_\_\_\_\_

TV Count \_\_\_\_\_

SS Count \_\_\_\_\_

Diagnostic Counters

One \_\_\_\_\_ Two \_\_\_\_\_ Three \_\_\_\_\_

Four \_\_\_\_\_ Five \_\_\_\_\_ Six \_\_\_\_\_

Seven \_\_\_\_\_ Eight \_\_\_\_\_ Nine \_\_\_\_\_

Ten \_\_\_\_\_ Eleven \_\_\_\_\_ Twelve \_\_\_\_\_

Right Ascension T (1) \_\_\_\_\_ radians T (105) \_\_\_\_\_ radians

Declination T (1) \_\_\_\_\_ radians T (105) \_\_\_\_\_ radians

ZETA \_\_\_\_\_

# T T T A B SUBROUTINE

## CALLING SEQUENCE:

CALL T T T A B

PZE O, O, Record number  
Return

PURPOSE: Given the record number, T T T A B pulls out the proper record from the T C T E table and converts the digital representation of  $T_c$  and  $T_e$  to fixed point numbers.

## METHOD:

1. If KAPPA is not O (the ground demodulation equipment does not make automatic corrections for temperature variations in  $T_e$ ) the program halts. In the normal case  $KAPPA=O$ .
2. Pick out the desired record from TC TE and check the record number which appears in the decrement of the data word.  
Halt if they don't agree.
3. The fixed point digits representing  $T_c$  and  $T_e$  are separated from the record and floated. Then tables TBL 12 and TBL 11 are interpolated.
4. The resulting floating point values of  $T_c$  and  $T_e$  are fixed and stored in  $BUFER+13$  and  $BUFER+12$  respectively.

X C S A P 2 SUBROUTINE

CALLING SEQUENCE:      CALL XCSAP2, NEWDEC, NEWRA  
                              Return

PURPOSE:    If the program parameter IOTA, which is read in on the documentation card, is equal to 1 instead of 0, a card is read by XCSAP2 containing alternate values for the right ascension and declination to replace the attitude data in the RATAB and DECTAB. The new attitude data is stored in NEWDEC and NEWRA.

METHOD:    One card is read with FORMAT ( F 6.3, F 6. 3). The first number is placed in NEWDEC and the second goes in NEWRA.

Z E T A SUBROUTINE

CALLING SEQUENCE:      CALL ZETA  
                         PZE CSPIN, spin rate  
                         PZE CDFR, data sampling frequency  
                         Return, fl. pt. ZETA in A C

PURPOSE: Given the spin rate in degrees and the data sampling frequency in cycles of A 550KC tuning fork calculate ZETA, the number of I R responses per satellite revolution.

METHOD:

$$ZETA = \frac{360 \times 550}{Spin \times data \text{ sampling freq.}}$$

## SENSE SWITCH SETTINGS

- 1      up     - Read the initial record on the IR tape.  
       down - Skip the initial record on the IR tape.
- 2      up     - Write output for FMRT on A6 and B6.  
       down - Do not write output for FMRT on A6 and B6.
- 3      up     - Write output for FMRT on A7 and B7.  
       down - Do not write output for FMRT on A7 and B7.
- 4      up     - Do not print diagnostic data from DETAIL on line.  
       down - Print on line the diagnostic data from DETAIL which is being written  
             on B3.
- 5             - Not used.
- 6      up     - At the end of orbit FINIS clears upper memory, skip over EOF on  
             B4 and transfers to 170.  
       down - FINIS writes a second EOF on the FMR tapes, rewinds and unloads  
             them and halts.

- 1      Used in repetitive reading of IR data records.
- 3      Used to find correct orbital data.
- 5      Set to 1 at beginning of a file and set to 0 when first useable data word is found to be below threshold.
- 6      Set to 0 at beginning of swath. Proceed to count responses, find direction and sensor.
- 7      0 - Swath not completely below the horizon (called alternating mode).  
1 - Swath entirely below horizon (called backward mode).
- 8,9    0 - Forward viewing swath (floor side) in same direction as TV.  
1 - Rear viewing swath (wall side) opposite direction from TV.
- 10     Set to 1 at beginning of file.  
Set to 0 when first earth viewing response is detected.
- 11     0 - The particular swath appears abnormal. Label sign of three data words minus.
- 12     0 - Starting location of downward mode has not been adjusted.  
1 - The starting location of the downward mode has been adjusted so that the new swath contains an integral number of spin revolutions.
- 15     0 - LALO has not yet been called  
1 - LALO has set up the angular distance between data points for this orbit.
- 16     0 - Either a data point is below threshold or it's above threshold and on the earth.  
1 - A data point is off the earth.
- 17     0 - LLA has not yet been called.  
1 - LLA has set up the angular distance between data points for this orbit.
- 18     0 - LALO is working on the first point in a swath.  
1 - LALO is working on the Nth point in a swath.
- 20     0 - Either earth and sky don't alternate or the responses in the alternating mode are within 25% of theoretical value.  
1 - The actual number of responses in the alternating mode differs from the theoretical number by more than 25%. Label sign of data words in swath minus.

DIAGNOSTIC COUNTERS

XCTR1	Increased by 1 when alternation of swaths is forced. The N.A. is near $90^0$ . (Subroutine DIRECT).
XCRT2	Increased by 1 when program makes a wrong decision and N.A. is not near $90^0$ (subroutine DIRECT).
XCRT3	Increased by 1 when a point in the alternating mode cannot be located on earth. (section 16)
XCRT4	Increased by 1 when a point in the downward mode cannot be located on earth. (section 17)
XCTR5	Increased by 1 when a swath in the alternating mode exceeds the maximum size for one spin revolution. (section 16)
XCTR6	Increased by 1 when a point in the alternating mode cannot be located on earth after one point has already been located on earth. (section 21)
XCTR7	Increased by 1 when a swath in the alternating mode exceeds the maximum size for one spin revolution after one point has already been located on earth. (section 21)
XCTR8	Increased by one when a point in the downward mode cannot be located on earth after one point has already been located on earth. (section 21)
XCRT9	Increased by one when a point in the alternating mode is assumed not to be located on earth at the end of a swath. XCTR9 should equal XCTR3. (section 23)
XCTR10	Increased by one for each data word placed in the WRITE buffer with a negative sign. (section 18 and 22)

DIAGNOSTIC COUNTERS CON'T.

- XCTR11      Increased by one for each useable data word skipped over on the IR input tape after the end of tape signal on FMRT and before the IR end of file mark. (section 26)
- XCRT12      Increased by one each time the first alternating mode goes back to seek the first response below threshold.
- XCTR3A      Keeps cumulative count of XCTR3 for each swath.

Format	Symbol	Definitions
I 4	COBN	Orbit number at time of interrogation
F 4.0	CDAY	Julian time of interrogation, day
F 2.0	CHR	hour
F 2.0	CMIN	minute
F 6.3	CSEC	seconds
I 2	CYR	Calendar year
I 2	CMO	month
I 2	CDY	day
F 6.5	CSSDLY	Sun sensor delay. Time between samples. (secs.)
F 6.5	CTVDLY	TV delay. Time between samples (secs.)
F 6.3	CSPIN	Spin rate of satellite (deg. / sec.).
I 3	CDFR	Data sampling frequency, 36, 72 or 144 cycles.
I 1	CSTCOD	Station code: 1 Ft. Monmouth; 2, San Nicholas Is.
I 3	CRVAL	Threshold value for Channel 4
I 1	IOTA	Take attitude from tape (o) or card (l)
I 1	KAPPA	Normally, automatic corrections for variations in $T_e$ are made by ground demodulation equipment (o). This is not done by ground demodulation equipment, therefore, stop (l)
I 1	RHO	Take $T_e$ and $T_c$ from tape (o) or card (l)
F 5.1	CTE	Temperature of electronics (deg. K )
F 5.1	CTC	Temperature of radiometer (deg. K )
I 1	CHANEL	Indicates which channel (2 or 4 ) will be used to correlate attitude. Any other number will cause a stop.

## Equivalent Symbol

IRDOC	YRFX	Calendar year
+ 1	MOFX	Calendar month
+ 2	DYFL	Calendar day
+ 3	RFED	Julian day of interrogation
+ 4	RFEH	Julian hour
+ 5	RFEM	Julian minute
+ 6	RFES	Julian seconds
+ 7	SSDLY	SS delay between samples
+ 8	TVDLY	TV delay between samples
+ 9	SPIN	spin rate of satellite
+ 10	DATFR	sampling frequency of IR data
+ 11	OBN	Orbit number
+ 12	STACOD	Station code (1, Ft. Monmouth or 2, San Nicholas Island.)

## A. Orbital Tape Documentation Record

## Equivalent symbols

ORDOC + 1	DREF	(see symbol definition)
+ 2	OTSD	} Orbit tape start time, day, hour, minute
+ 3	OTSH	
+ 4	OTSM	
+ 5	OTED	} Orbit tape en. day, hour, minute
+ 6	OTEH	
+ 7	OTEM	

## B. Orbital Tape Data Record

## Equivalent symbols

ODATA + 1	ORDAY, ORREC + 1	} Time identifying the following data, day, hour, minute.
+ 2	ORHR, ORREC + 2	
+ 3	ORMIN, ORREC + 3	
+ 4	latitude	
+ 5	longitude	
+ 6	height	
+ 8	R. A.	
+ 9	declination	
+ 14	N.A.	
+ 15	P supp. (not used).	

## SYMBOL DEFINITIONS

DBGOD1 DBGOD2 DBGOD3	Time associated with the first record of orbital data stored in ODATA: day, hour and minute.
FIRST	Contains the first or identifying record of the IR tape, -377 000 000 000.
FCDFR	Sampling frequency of data, fl. pt.
CDYFL	Calendar day, fl. pt.
RCTR	The count of the number of records on the IR tape read by the program.
BANK	Number of seconds from 0 hr., 0 min. of base day, BDAY, to the time of interrogation.
BDAY	Base day: If less than 120 minutes have passed from midnight to interrogation (CHR less than 2) $BDAY = CDAY - 1$ . Otherwise, $BDAY = CDAY$ .
ALPHA	(BSS 5) Temporary storage.
RFET	Number of seconds from 0 hour, 0 minute of CDAY to the time of interrogation.
RFED RFEH RFEM RFES	Time of interrogation, RFET, broken down into day, hour, minute and seconds.
CLOCKA	Number of seconds from 0 hour, 0 minute of CDAY to time of interrogation.
CLOCKB	Start time corrected to the earlier exact minute (in seconds).
CLOCKC	Number of seconds from 0 hr., 0 min. of CDAY to start time of this file of radiation data.
CLOCKD	Time of interrogation corrected to the later exact minute (in seconds).
CLOCKE	CLOCKB in minutes
TIME	The current value of time in seconds.
TINC	The increment to be added to time between data points on the IR tape. TINC depends on the sampling frequency.
RFST	The start time of this file of radiation data. $RFST = RFED - N (TINC)$ where N is the number of data words on the IR tape.

RFSD RFSH RFSM RFSS	The start time of this file of radiation data, RFST, broken down into day, hour, minutes and seconds.
OTED OTEH OTEM	The orbital tape end time taken from the orbital tape documentation record: day, hour and minute.
OTET	The orbital tape end time computed from OTED, OTEH, OTEM in seconds.
OTSD OTSH OTSM	The orbital tape start time taken from the orbital tape documentation record: day, hour and minute.
OTST	The orbital tape start time computed from OTSD, OTSH, OTSM in seconds.
ORT1 ORT2 ORT3	Temporary storage used to keep track of the time of a record on the orbital tape when it is being positioned.
COUNT	Counting register.
WATCH	Initially set equal to CLOCKB.
DIAL	The current value of the number of seconds past the last exact minute.
TVCTR	The counter of TV code words on the IR tape.
SSCTR	The counter of SS code words on the IR tape.
DATCTR	Set at the beginning of a swath to the number of data points in the swath.
WATCH2	The time (Julian day, hour and minute) in seconds at the beginning of an FMRT record.
HMS1 HMS2	WATCH2 expressed in days. HMS1x360, time in degrees.
DYFL2	Calendar day (CDYFL2) fl. pt. HMS1.
TINCX	Time increment between samples of medium resolution radiometer, fx. pt.
STTIM	Start time for a particular swath.
ENDTIM	End time for a particular swath.

MINTIM	Average time for a swath: $STTIM + (ENTIM - STTIM) / 2$ .
LGHAA	GHA Aries.
COLATA	Colatitude of SSP.
LONGA	$2\pi - L$ ; $L$ = longitude SSP - $2\pi N$ , where $N$ is the value necessary to make $L < 2\pi$ .
COLATB	Colatitude of SAP.
LONGB	Let R.A. - LGHAA = $Y$ . If $Y$ is positive, $LONGB = 2\pi - Y$ . If $Y$ is negative, $LONGB =  Y $ .
TEST2	Count of the number of points in a swath to be discarded.
SIGNAD	Set equal to N.A. if floor side is used and $180^\circ$ - N.A. for wall side.
CMO CMO2	Temporary storage for month used in computation of solar ephemeris.
DGNDAY DGNHR DGNMIN DGNSEC	Time associated with the first response in a swath greater than critical value: day, hour, minute and second.
DGNNA	Nadir angle at the time of the first response in the swath.
DGNCT1	Number of responses in the swath, using AHEAD.
DGNCT2	Number of responses in the swath past three below threshold, using AHEAD2.
DGNCT3	Theoretical number of responses in the swath, SIGMA.
DGNCT4	The final or actual responses processed in the swath.
DGNCT5	The number of responses discarded to adjust starting location of downward mode.
SAVIND	Storage for sense indicators (SI).
XDOCK	Keeps count of number of discrepancies when comparing documentation card with IR tape documentation record.
LCORR	Counter of multiples of $2\pi$ used in correcting LONTAB if necessary.
MASK 2	End of file code word.

MASK3	End of record code word.
MASK4	T V code word.
MASK5	SS code word.
DREF	Number of days between zero hour of 9/1/57 and zero hour of launch day.
ORDAY	The time identifying the current orbital data record: day, hour, and minute.
ORHR	
ORMIN	

# DIRECT SUBROUTINE SYMBOL TABLE

DRCT85	Time of first IR response, T minutes
DRCT86	N.A. of camera at T
DRCT87	N.A. of camera at $T+.5$
DRCT88	N.A. of camera at $T+1.$
DRCT89	N.A. of camera at $T+1.5$
DRCT90	N.A. of camera at $T+2.$
DRCT91	Counter for data words above threshold within a swath.
DRCT92	Counter for number of swath
DRCT93	Temporary storage when determining increasing or decreasing swath count in alternating mode.
DRCT94	Address of first IR response in this swath
DRCT95	RDATA $+4200$
DRCT96	SWCT in address
DRCT97	K (constant)
DRCT98	swath count
DRCT99	Address of swath count $+NN$
PRECT	Previous swath count
PRECTA	PRECT $+3$
PRECTB	PRECT $-3$
FLZETA	$2 * ZETA$ , fl. pt.
HEIGHT	Satellite height
LATSSP	Lat. SSP
LONSSP	Long. SSP
LATSAP	Lat. SAP
LONSAP	Long. SAP
FLSWCT	Swath count
SWCT90	Swath count when N.A. $= 90^0$ (fx. pt.)
RECNT	Record count
ANGLE1	The angle at which the first sensor, which has been viewing the earth continuously, just starts seeing the horizon.
ANGLE2	The angle at which the second sensor starts viewing the earth and alternation starts.

ANGLE3      The first sensor which was viewing earth when  $N.A. \neq 0$  is now  
viewing space exclusively.

ANGLE4      The second sensor stops viewing space and views earth only.

ANGLE5       $ANGLE\ 2 + 5^0$

ANGLE6       $ANGLE\ 3 - 5^0$

## TABLES AND BLOCKS

LATTAB	(BSS 220) Latitude of SSP. Constructed from orbital tape. Arranged in order of increasing time there are 105 pairs of entries: t (secs), lat. SSP (t).
LONTAB	(BSS 220) Longitude of SSP. Constructed from orbital tape. Arranged in order of increasing time there are 105 pairs of entries: t (secs.), long. SSP (t).
HTTAB	(BSS 220) Height of satellite. Constructed from orbital tape. Arranged in order of increasing time there are 105 pairs of entries: t (secs.), height (t).
RATAB	(BSS 220) Latitude of SAP. Constructed from orbital tape. Arranged in order of increasing time there are 105 pairs of entries: t (secs) R.A. (t).
DECTAB	(BSS 220) Declination table. Used to find longitude of SAP. Constructed from orbital tape. Arranged in order of increasing time there are 105 pairs of entries: t (secs.), DEC. (t).
NATAB	(BSS 220) Nadir Angle of camera axis. Constructed from the orbital tape. Arranged in order of increasing time there are 105 pairs of entries: t (secs.), N. A. (t).
PSTAB	(BSS 220) P sup table - not used.
ORBUF	(BSS 16) Orbital tape document record read in here.
ORDOC	(BSS 16) Values in ORBUF are floated and stored in ORDOC.
IRBUF	(BSS 18) IR tape BCD documentation record read in here.
IRBUF2	(BSS 18) IRBUF BCD data converted to binary and stored here.
IRDOC	(BSS 18) IRBUF2 data stored in IRDOC with some values floated.
RDATA	(BSS 8400) IR tape data record stored here.
TCTE	(BSS 100) Temperature table. The word following the EOR on the IR tape contains $D_o(T_c)$ and $D_o(T_e)$ in the decrement. These are stored as an entry in the TCTE table in the address of a word with the record number in the decrement. See TBL11 and TBL12.
ORREC	(BSS 4) The first four words of an orbital tape record are stored here. This is the time which identifies the record.

OMEGA (BSS 12) Temporary storage for a particular swath

OMEGA Julian day

+ 1 Julian hour

+ 2 Julian minute

+ 3 Julian seconds

+ 4 GHA of sun and declination

+ 5 ZETA (IR responses / revolution)

+ 6 No. of responses in this swath

+ 7 No. of responses past 3 below threshold. (If OMEGA  
 $+6 < 3 * ZETA$ , store OMEGA+7 in OMEGA+6).

+ 8 Computed SIGMA fl. pt.

+ 9 Computed SIGMA fx. pt.

+ 10  $.75 * SIGMA$  fx. pt.

+ 11  $1.25 * SIGMA$  fx. pt.

BUFER (BSS 35) Temporary Storage

BUFER satellite height

+ 1 lat. SSP

+ 2 long. SSP

+ 3 lat. SAP

+ 4 long. SAP

+ 5 identifier for subroutine EARTH

+ 6  $\Delta\alpha$ , used by EARTH

+ 7  $\Delta\beta$ , used by EARTH

+ 8 lat. viewed point

+ 9 long. viewed point

+ 10 N.A. of IR optic axis

+ 11 Azimuth of IR optic axis

+ 12	$T_c$
+ 13	$T_e$
+ 14	GHA aries
+ 15	Angle 1
+ 16	Angle 2
+ 17	Angle 3
+ 18	Angle 4
+ 19	ZETA
+ 20	SPIN
+ 21	N.A. of camera
+ 22	sampling frequency
+ 23	minimum N.A. in swath
+ 24	Azimuth corresponding to minimum N.A.
+ 25	lat. corresponding to minimum N.A.
+ 26	long. corresponding to minimum N.A.
+ 27	
+ 28	
+ 29	
+ 30	
+ 31	
+ 32	
+ 33	
+ 34	

TVBUF (BSS 300) when a TV code is encountered on the IR tape the word following is low resolution data which is stored in TVBUF preceded by the current TIME minus CTVDLY.

SSBUF (BSS 900) when a SS code is encountered on the IR tape the current value of TIME minus CSSDLY is stored in SSBUF.

BFR (BSS 15) Temporary storage used by subroutines.

TAU (BSS 5) the subroutine CALIB usually stores its results as follows.

- W (ch.1) TAU decr.
- W (ch.2) TAU addr.
- W (ch.3) TAU+1 decr.
- W (ch.4) TAU+1 addr.
- W (ch.5) TAU+2 decr.

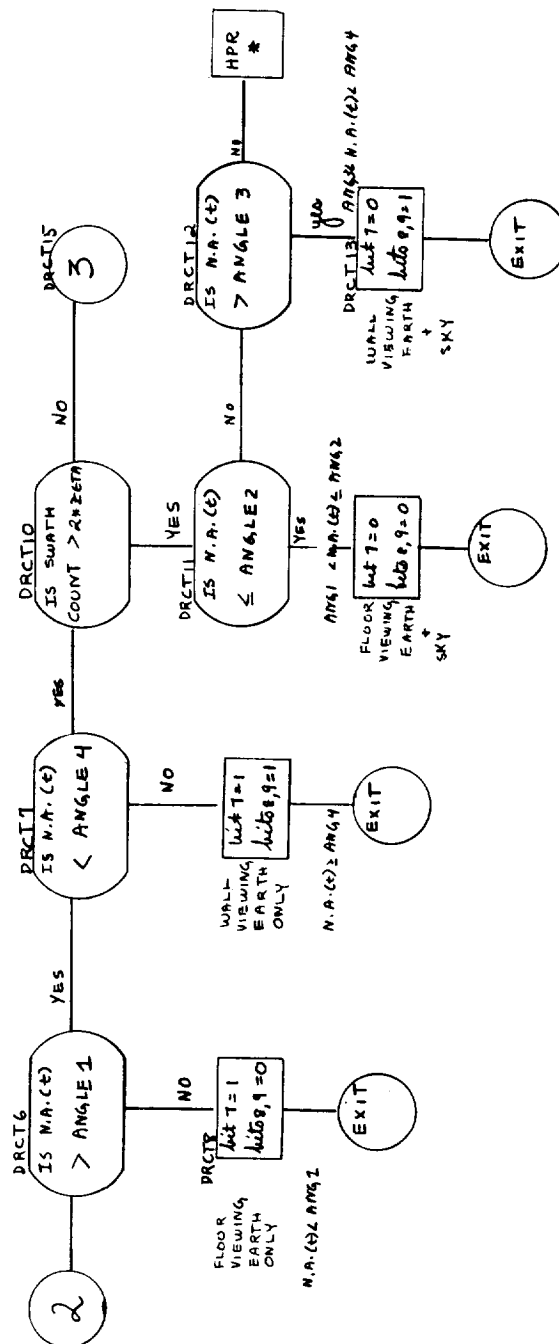
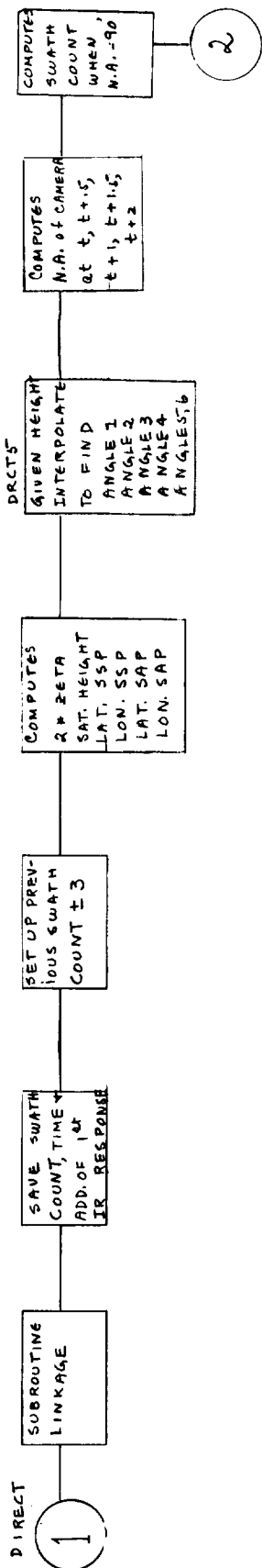
WRITE	(BSS 4200) The output buffer for one record of FMRT data. Cleared after each record is written on tape.
ODATA	(BSS 1870) The input buffer for the orbital tape.
TBL1	(BSS 168) Used by CALIB. Table of D1, 7 bit digit which is part of IR data word, vs. $T_{bb}$ temperature of black body, as a function of $T_c$ . There are 8 values of $T_{bb}$ with 10 pairs of D, $T_{bb}$ per $T_c$ . Represents thermal Ch. 1 of radiometer, floor side.
TBL2	(BSS 168) Used by CALIB. Table of D2, 7 bit digit which is part of IR data word, vs. $T_{bb}$ . Constructed like TBL1. Represents thermal ch. 2 of radiometer, floor side.
TBL3	(BSS 168) Used by CALIB. Table of D3, 7 bit digit which is part of IR data word, vs. energy in watts/sq. meter. Constructed like TBL1. Represents solar ch. 3 of radiometer, floor side.
TBL4	(BSS 168) Used by CALIB. Table of D4, 7 bit digit which is part of IR data word, vs. $T_{bb}$ . Constructed like TBL1. Represents thermal ch. 4 of radiometer, floor side.
TBL5	(BSS 168) Used by CALIB. Table of D5, 7 bit digit which is part of IR data word, vs. energy in watts/sq. meter. Constructed like TBL1. Represents solar ch. 5 of radiometer floor side.
TBL6	(BSS 168) Same as TBL1, for wall side.
TBL7	(BSS 168) Same as TBL2 for wall side.
TBL8	(BSS 168) Same as TBL3, for wall side.
TBL9	(BSS 168) Same as TBL4, for wall side.
TBL10	(BSS 168) Same as TBL5, for wall side.
TABL1	(BSS 10) TABL1 through TABL6 are used to convert some BCD data in the IR documentation record to binary, base 35.
TABL2	
TABL3	
TABL4	
TABL5	
TABL6	
TABL7	(BSS 10) TABL 7 through TABL12 are used to convert some BCD data in the IR documentation record to binary, base 26.
TABL8	
TABL9	
TABL10	
TABL11	
TABL12	
MODAY	Table giving the number of days in the month from Dec. to Jan.

TBL11	(BSS 20) Used by TTTAB. Table of $D_o(T_e)$ , digit from table TCTE, vs. $T_e$ when automatic corrections for variations in $T_e$ are made by ground demodulation equipment.
TBL12	(BSS 20) Used by TTTAB. Table of $D_o(T_c)$ digit from table TCTE, vs. $T_c$ when automatic corrections for variations in $T_e$ are made by the ground demodulation equipment.
TBL13	Not used
TBL14	Not used
TBL15	Not used
TBL16	Not used
GHA	(BSS 144) Solar ephemeris table, Greenwich Hour Angle. Arranged in 12 groups representing months. Within each group the values of the GHA are listed for the 1st, 7th, 13th, 19th, 25th and 31st day, and are used as the basis for interpolation.
DEC	(BSS 144) Solar ephemeris Table, declination. Arranged in 12 groups representing months. Within each group the values of DEC are listed for the 1st., 7th., 13th, 19th, 25th and 31st. day and are used as the basis for interpolation.

FLOW CHARTS FOR SUBROUTINE  
"DIRECT" USED BY THE TIROS  
PROGRAM TO FIND THE DIRECTION  
OF VIEW AND SENSOR BEING USED



**DIRECT**



**KEY**

SENSE INDICATOR BITS  
7: 1 - CAMERA LOOKING STRAIGHT  
DOWN ON EARTH

eg: 1 - WALL SIDE OF RADIOMETER  
VIEWING EARTH

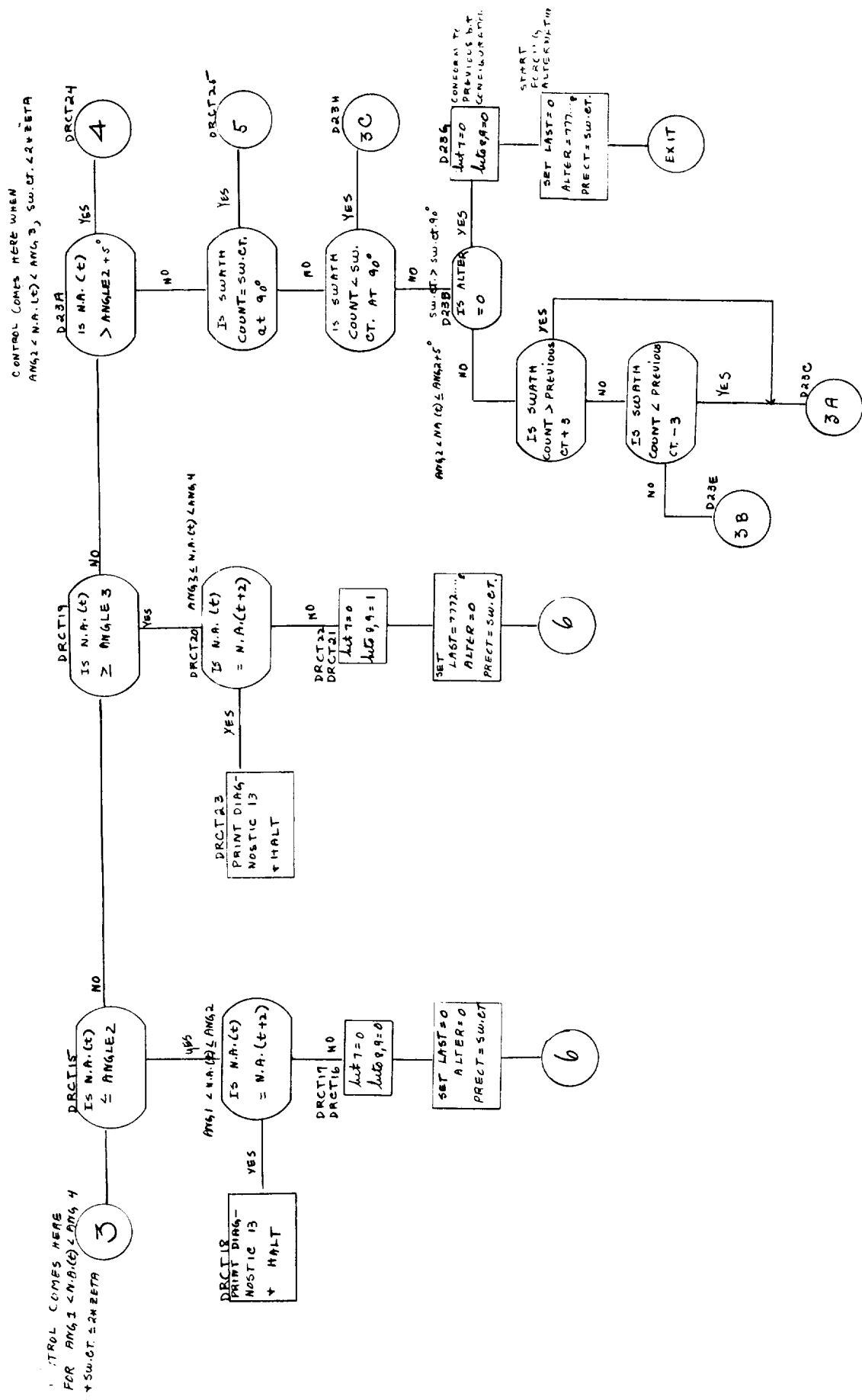
O - FLOOR SIDE VIEWING  
EARTH

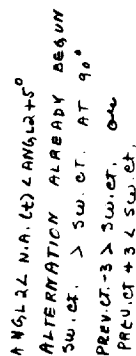
ALTER: 1 - ALTERNATION IS BEING FORCED

ALTERNATION IS NOT  
FORCED

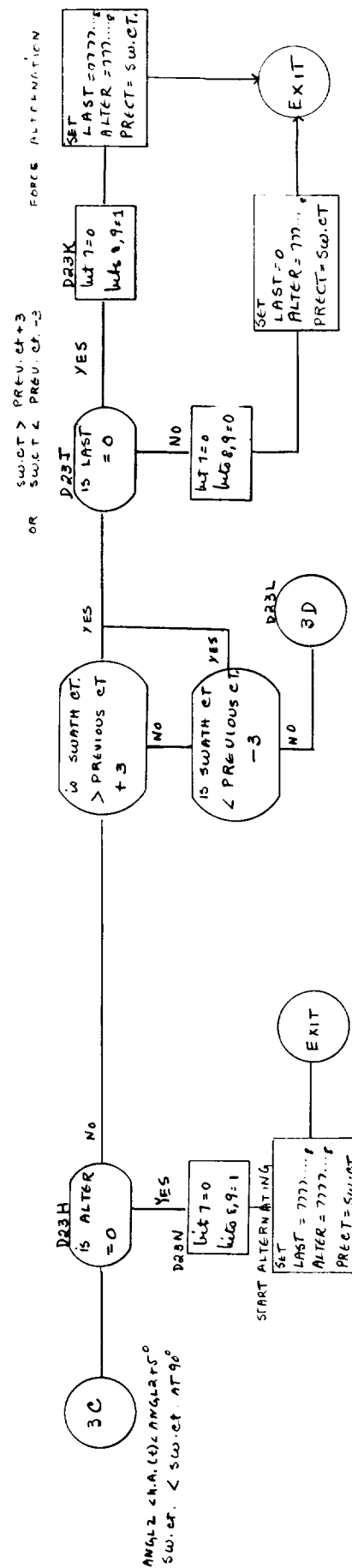
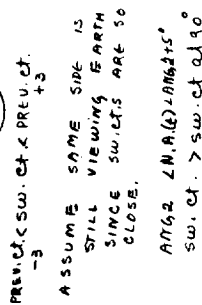
LAST : 1 - WHEN FORCING AIRFLOW-  
TION, LAST WING WILL

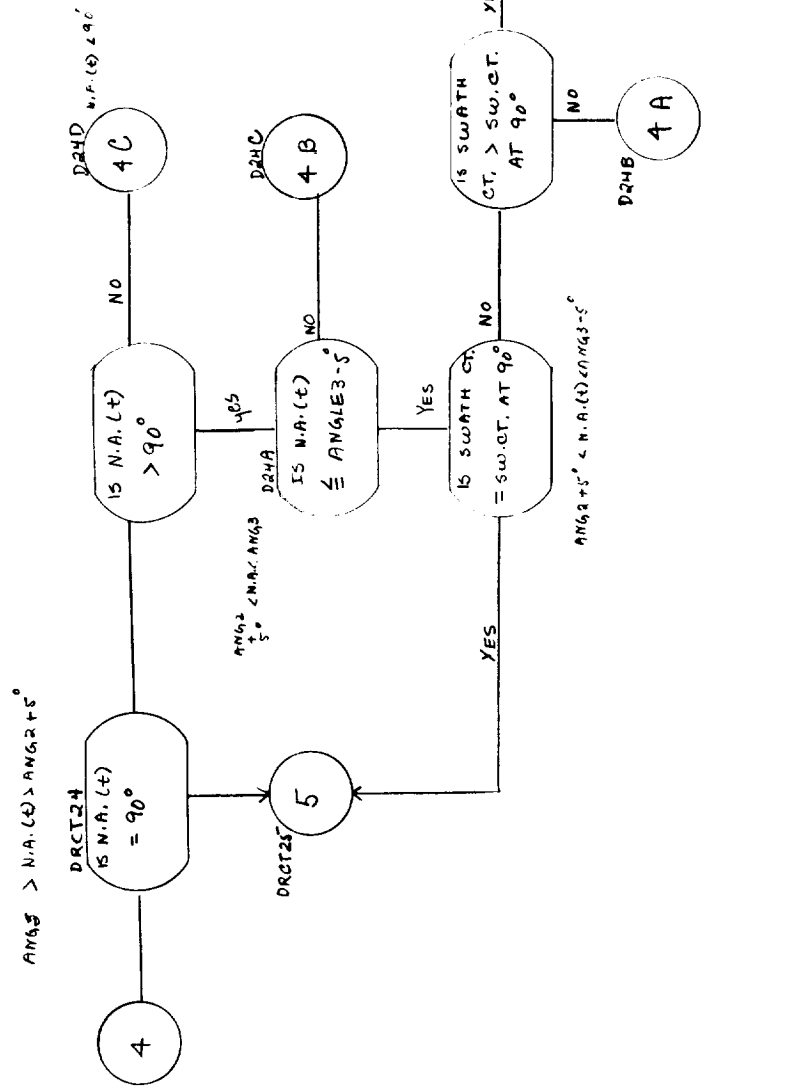
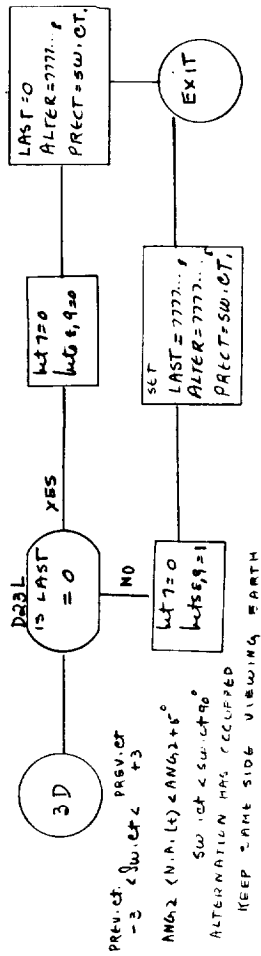
0 - LAST WIS FLOOD

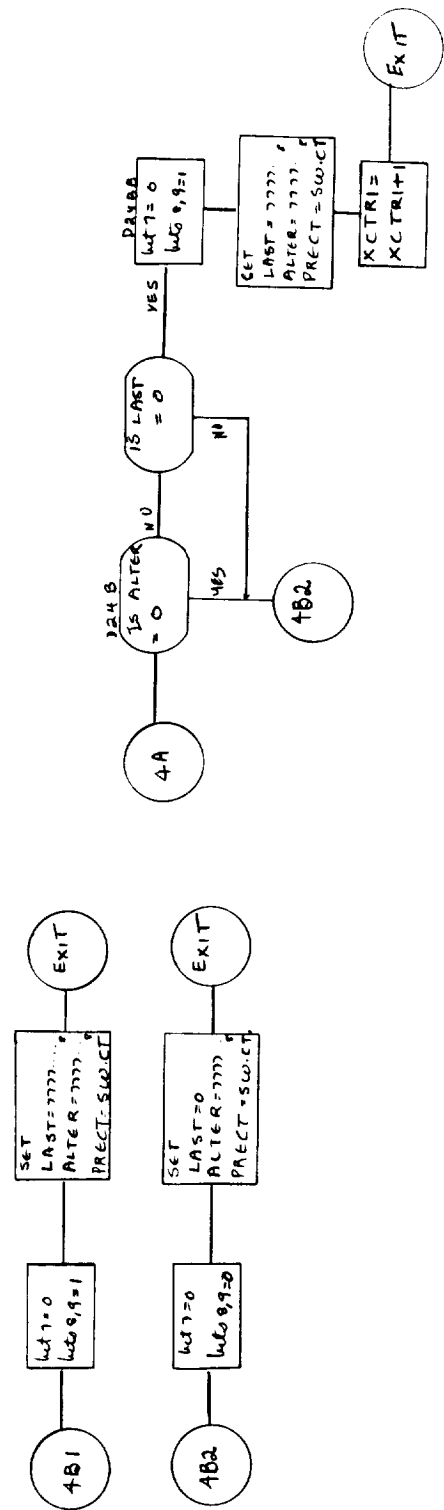
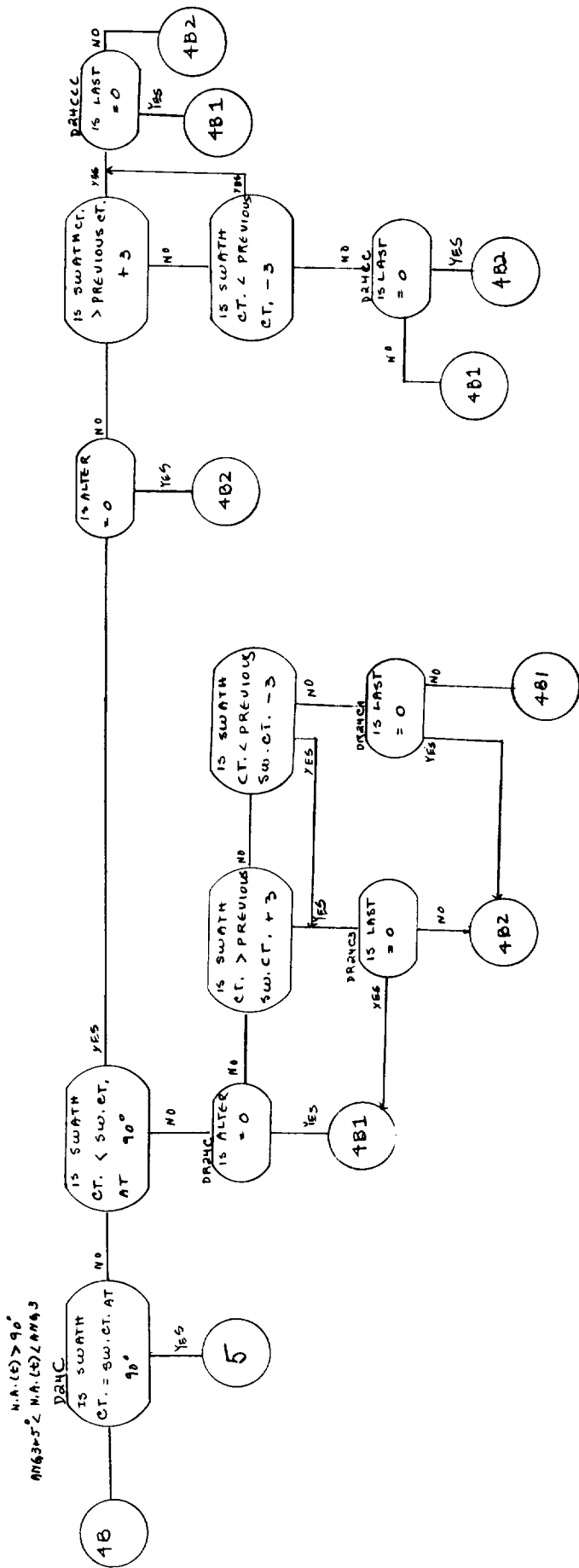




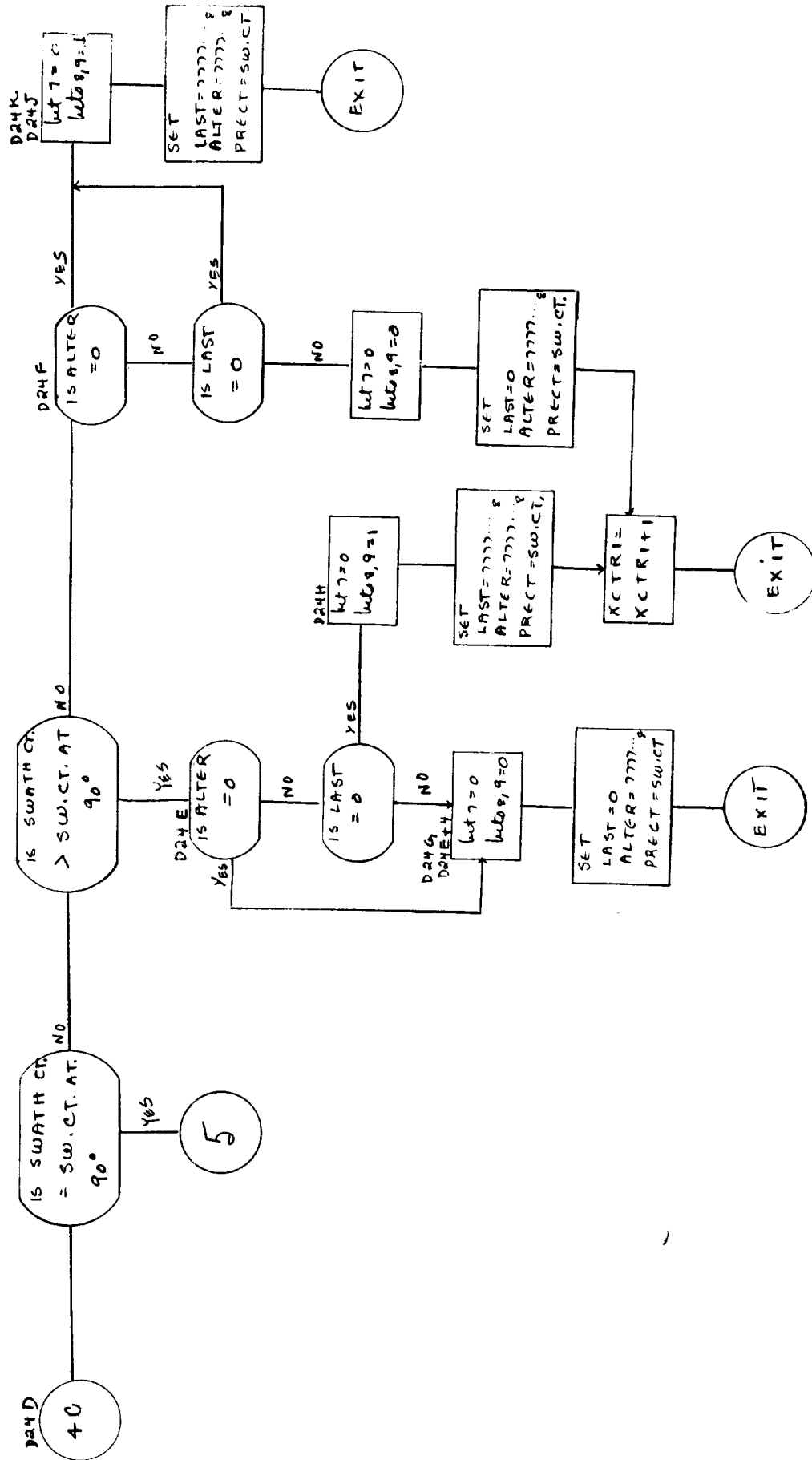
SWATH 0 EITHER DECREASING OR INCREASING. REVERSE SENDING



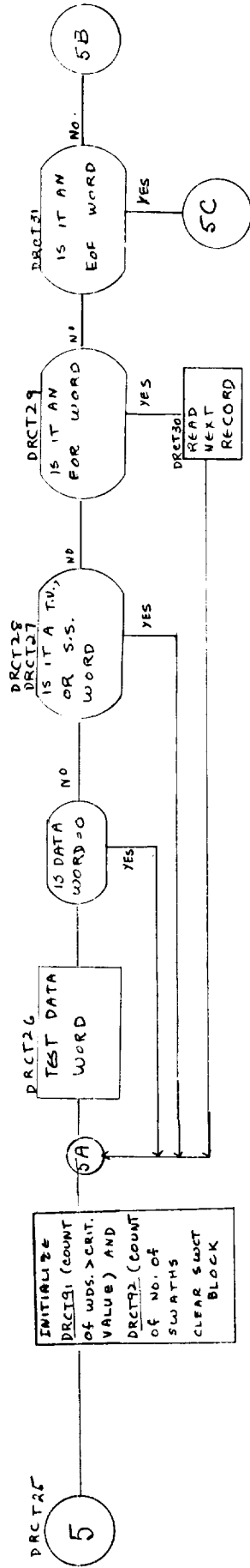




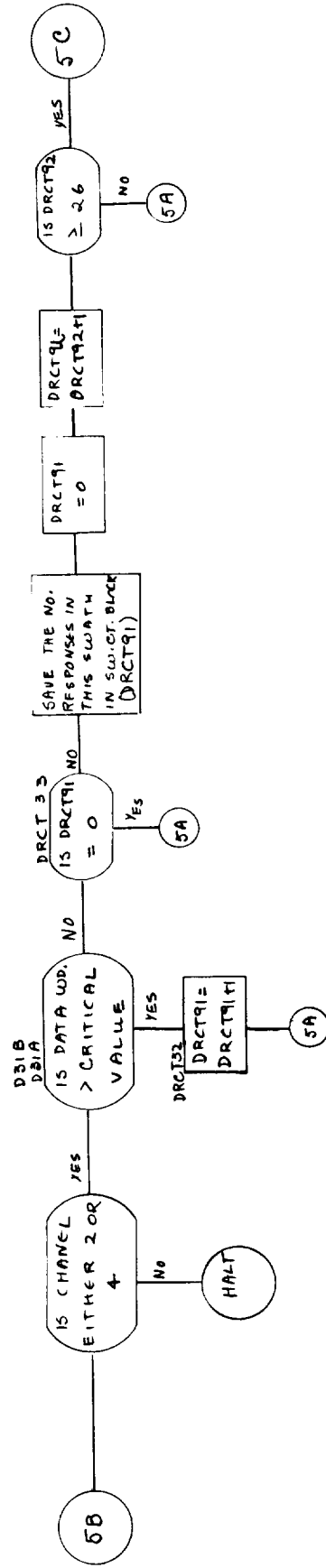
N.A.  $\angle 90^\circ$   
 AM62+502 M.A. (E)  $\angle$  ANG3



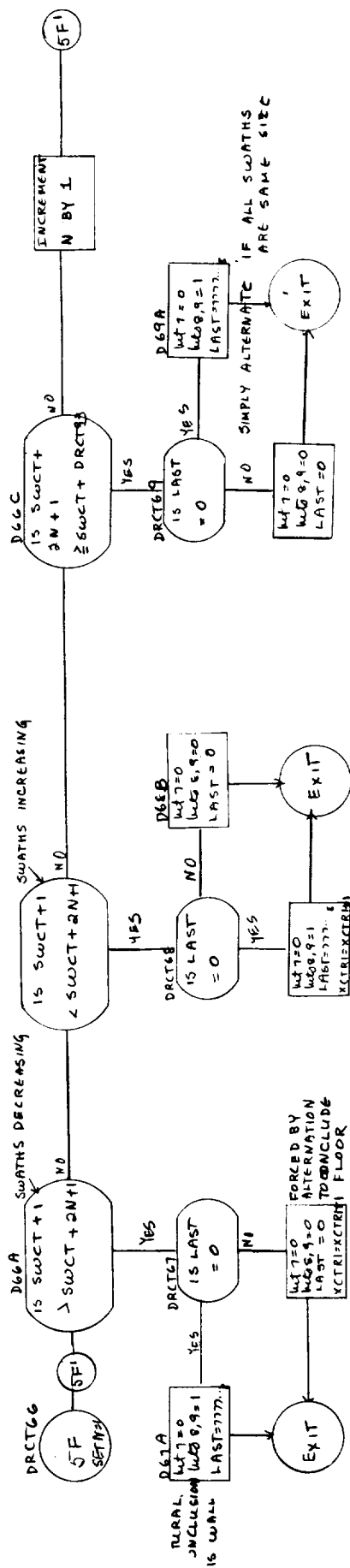
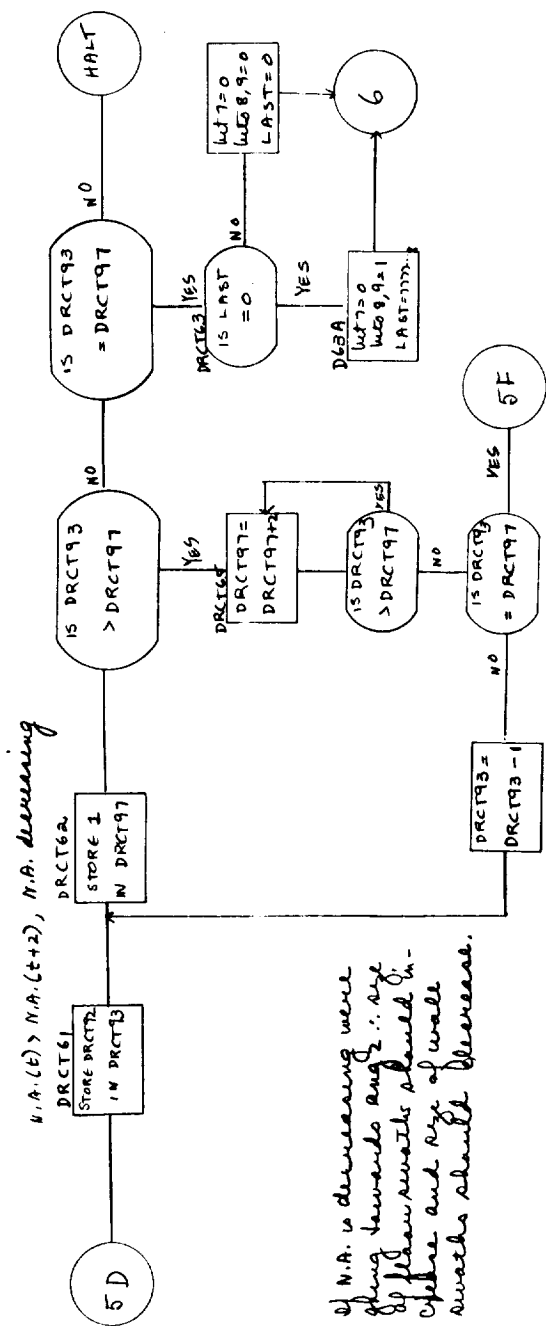
EITHER M.A. = 90° OR SWATH CT = SWATH CT. AT 90°

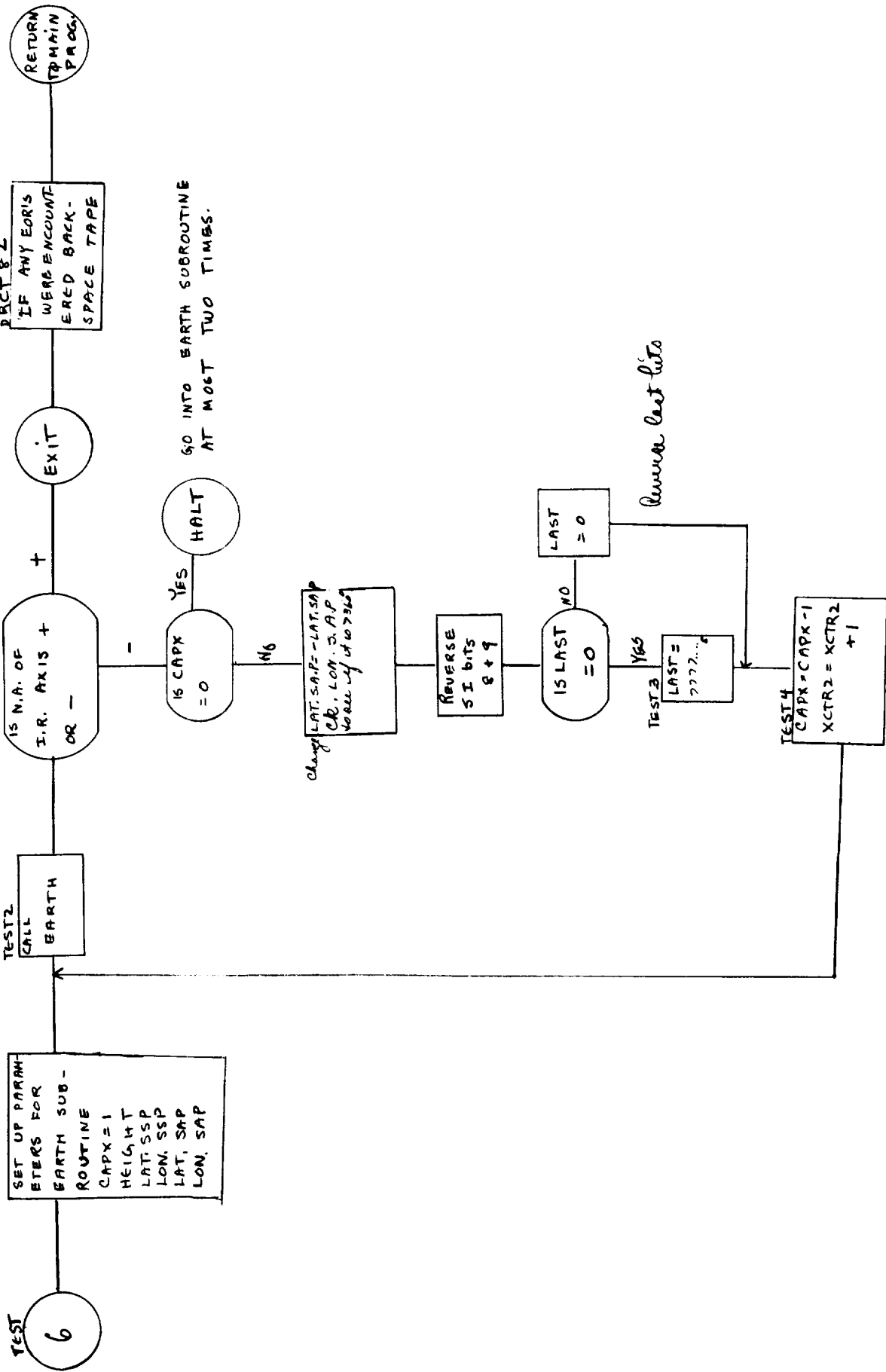


COUNT AHEAD 85 SWATHS OR  
UNTIL AN EOF IS ENCOUNTERED  
WHICHEVER OCCURS FIRST.



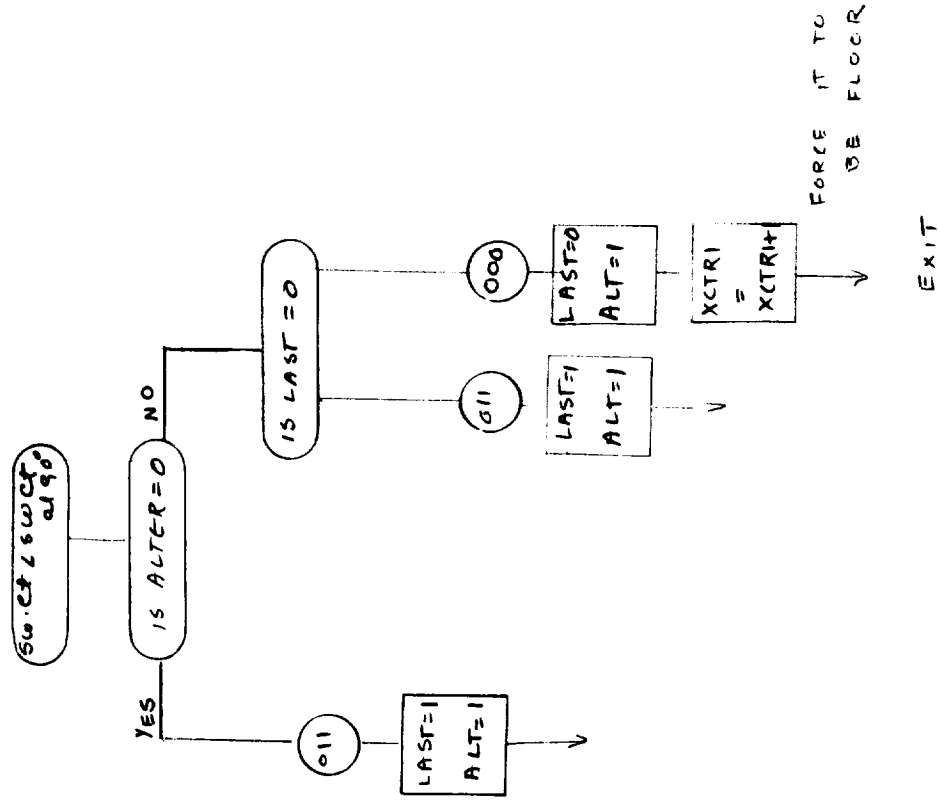
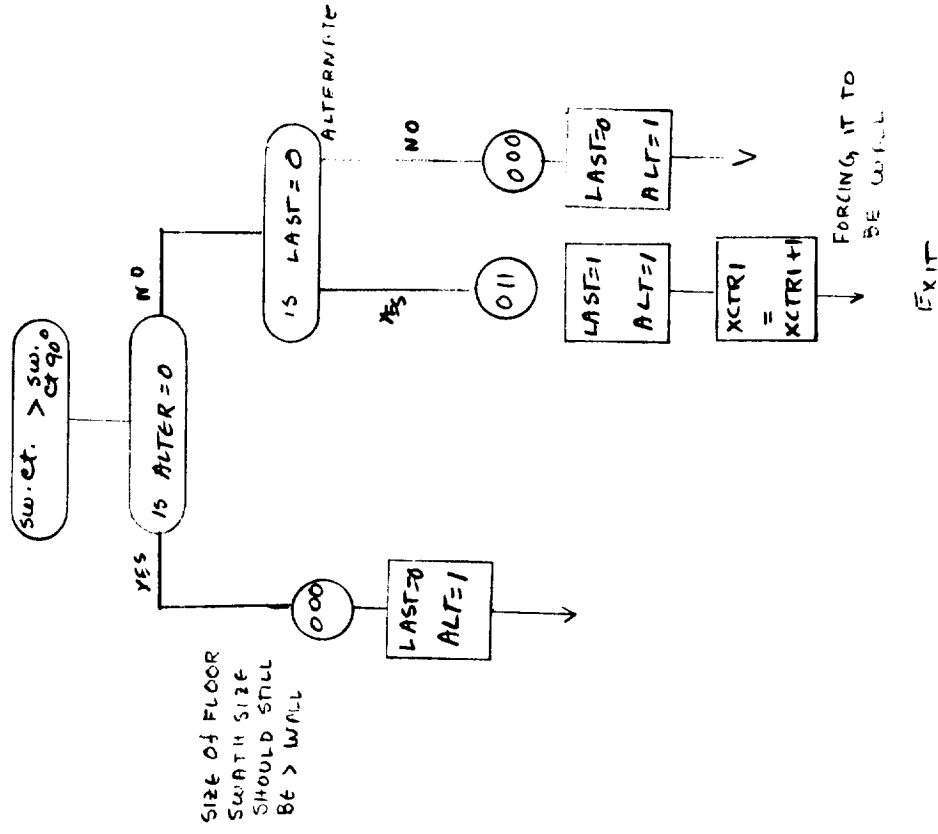




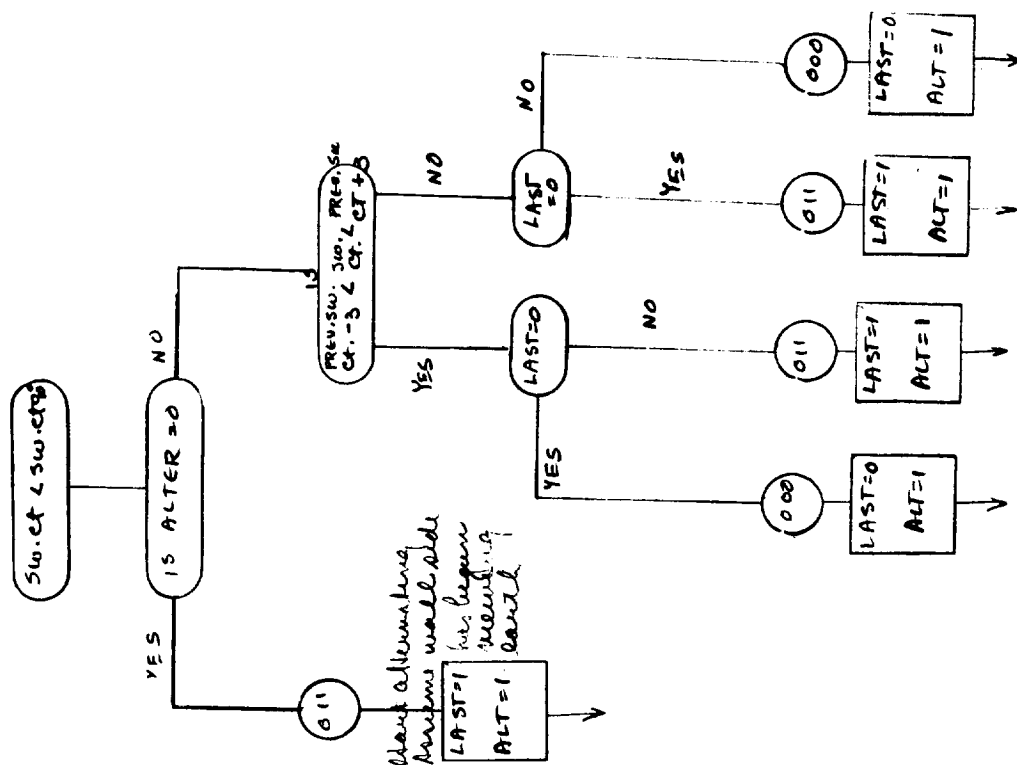
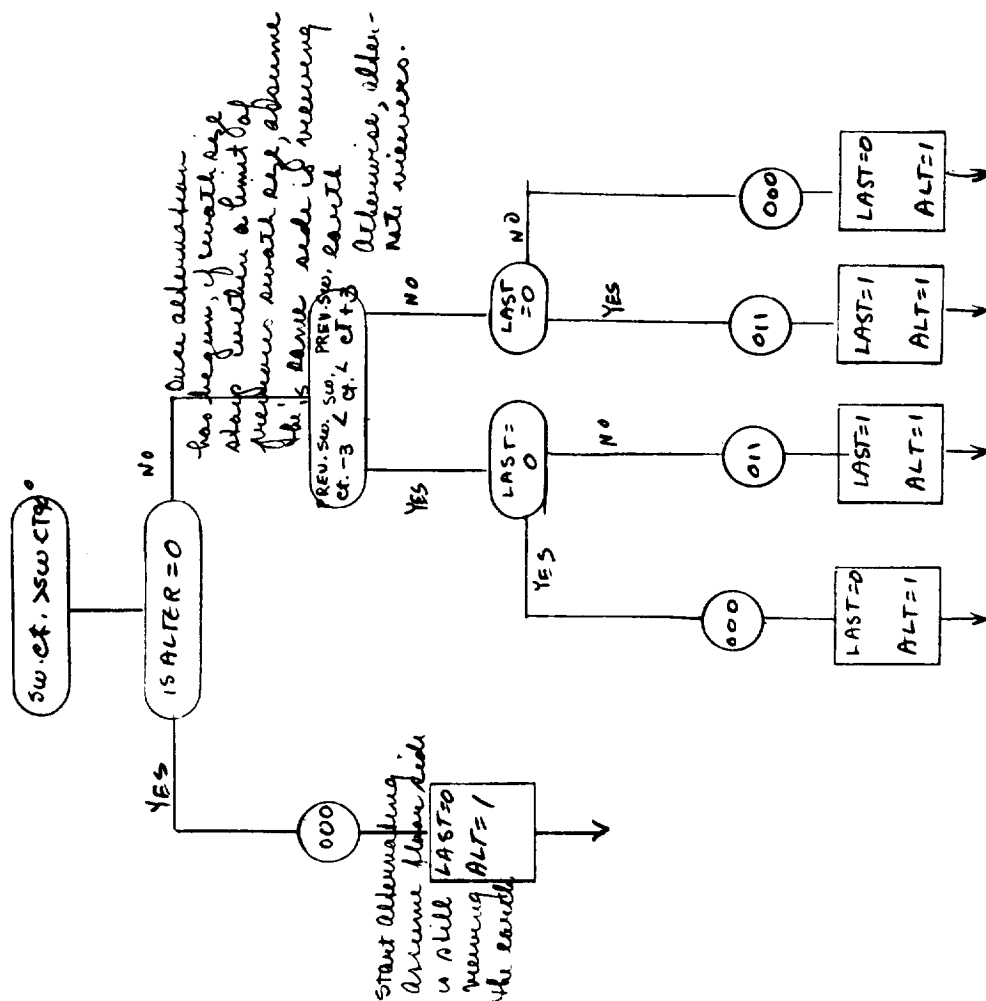


$$ANG2 \neq 5^\circ < N.A.(t) < ANG3$$

$$N.A.(t) < 90^\circ$$



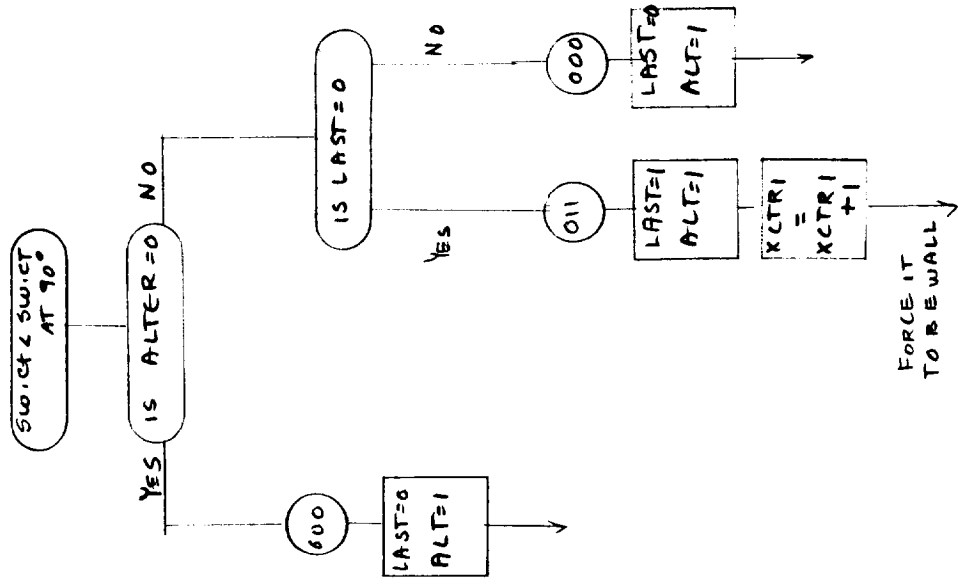
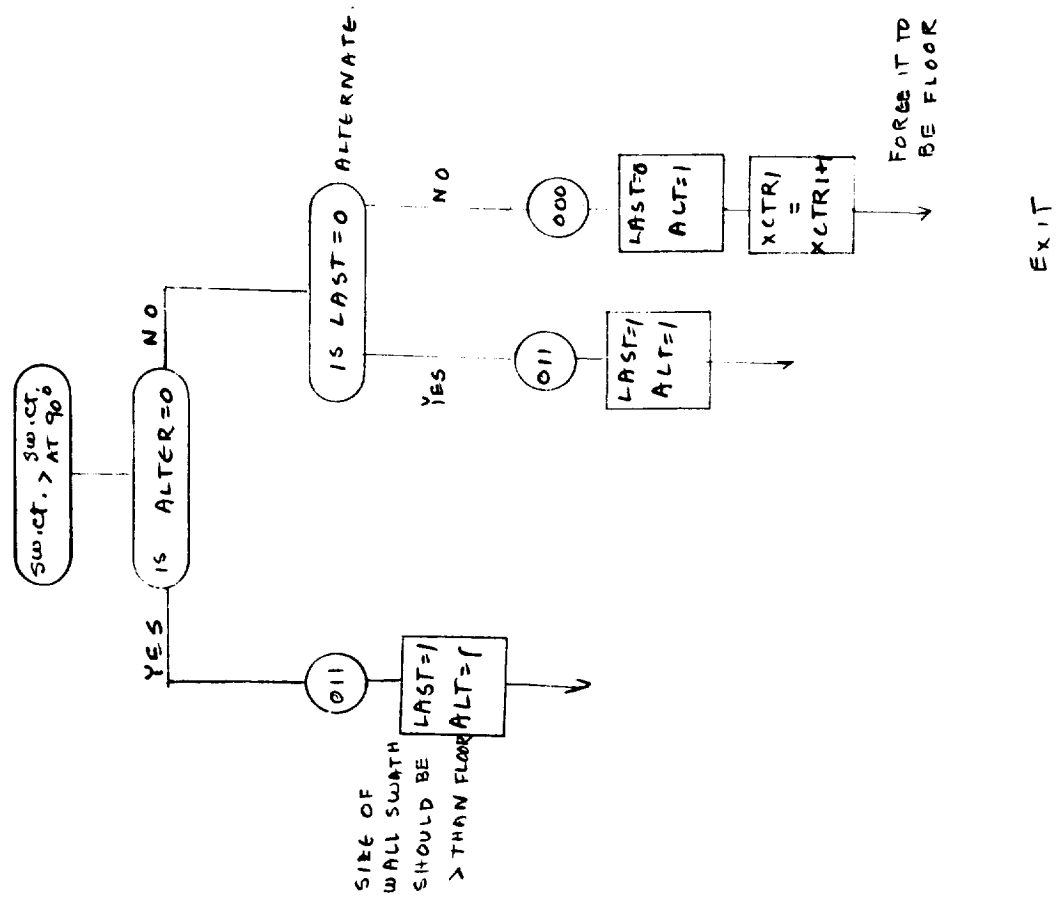
BREAKDOWN OF SPECIFIC CASES

$$\text{ANG}_2 \angle \text{N.A.}(\text{t}) \angle \text{ANG}_{2+5^\circ}$$

$$E, X, T$$


## Exit

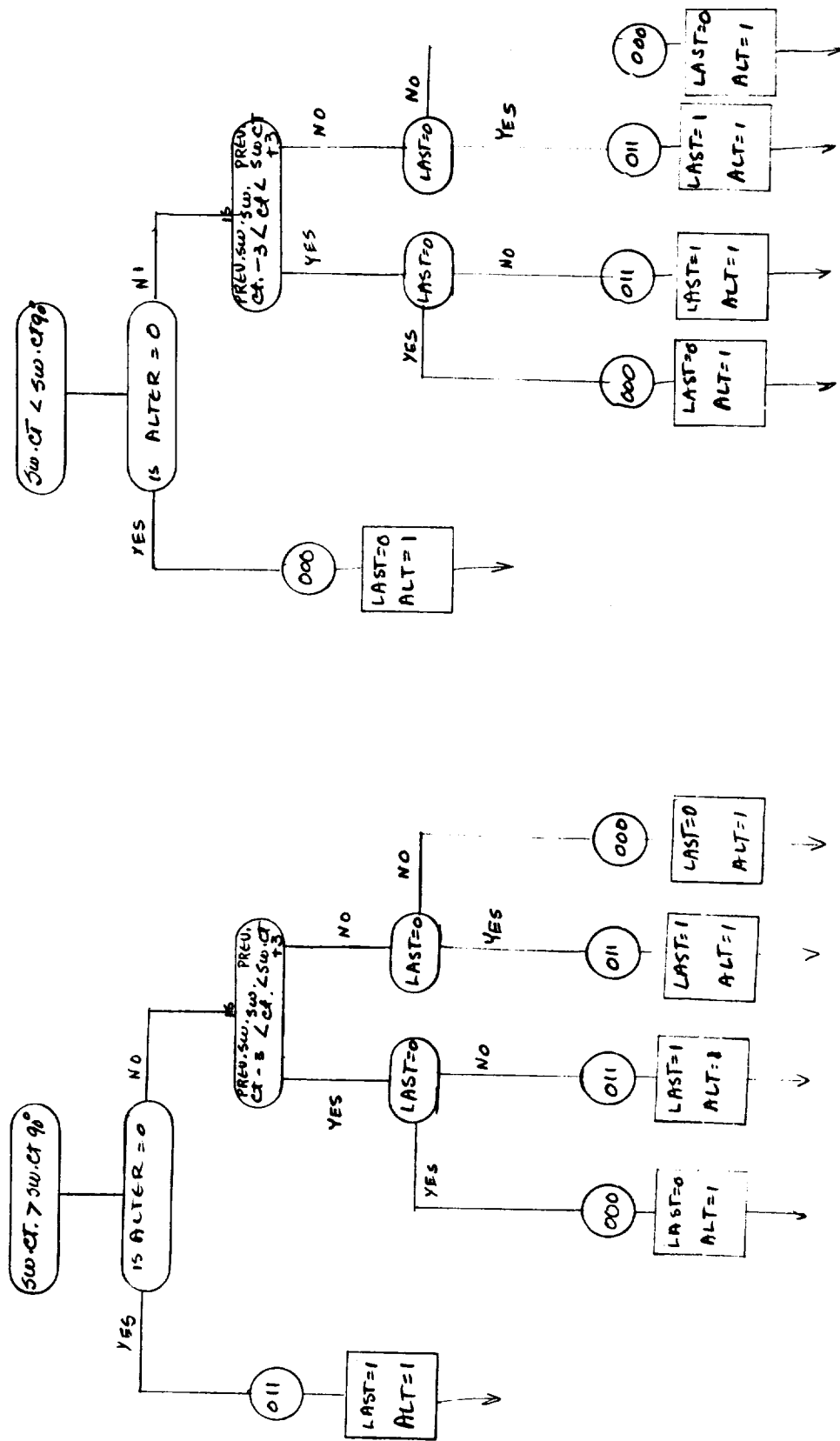
$$ANG2 + 5^\circ < N.A.(t) \leq ANG3 - 5^\circ$$

$$N.A.(t) > 90^\circ$$



ANG3-5° < N.A.(t) < ANG3

N.A.(t) > 90°



$$N.A.(t) = 90^\circ$$

IF THE # OF SWATHS  
IS AN ODD #, SAVE IT IN  
OTHERWISE REDUCE  
IT BY ONE = DRECT

